MECHANICAL ENGINEERING

· MAY 1948 ·

Departments

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 70 NUMBER 5

Contents for May, 1948

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York 18, N. Y. Cable address, "Dynamic," New York. Price 75 cents a copy, $7.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage outside of the United States of America, $1.50 additional. Changes of address must be received at Society headquarters three weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Member of the Audit Bureau of Circulations.

Students in Administrative Engineering at New York University Check Themselves on Reading a Stop-Watch

(The "wink" counter, shown in the foreground, was developed by Prof. D. B. Porter (upper left) and is used for analyzing small elements of time.)

Volume 70
No. 5

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GEORGE A. STETSON, *Editor*

Prime Movers Committee

IN view of the high praise which E. G. Bailey bestowed on the Prime Movers Committee in the address he delivered at the 1948 ASME Spring Meeting in New Orleans, published in this issue, further comment on the Committee may be of interest.

In the presidential address to the National Electric Light Association in 1903, Louis A. Ferguson said, "We should appoint a committee of three good mechanical engineers to follow the development of the steam turbine during the coming year and report the results at the next convention."

The committee appointed, known as the Committee for the Investigation of the Steam Turbine, was made up of Wm. C. L. Eglin, chairman, Fred Sargent, and A. C. Dunham. Its 1904 report reviewed the history of and described current developments in that prime mover. In 1905 the committee was enlarged to five members, among whom was Irving E. Moultrop. The 1906 report contained a supplementary section on European developments based on material gathered by Mr. Moultrop during a trip abroad. Its task completed, the steam-turbine committee asked to be discharged. In its place there was appointed, also under the chairmanship of Mr. Eglin, a Committee on Gas Engines. Mr. Moultrop and J. B. Klumpp were members of this committee and a report was presented in 1908. Mr. Klumpp succeeded to the chairmanship in 1909 and Mr. Moultrop in 1910.

The value of the work of these two committees suggested the desirability of organizing a standing committee of broader scope and larger membership; and in 1911, in the first report of the Prime Movers Committee, as it was called, Mr. Moultrop wrote: "The Prime Movers Committee, unlike its predecessors, the Steam Turbine Committee and the Gas Engine Committee, has no newly developed type of apparatus to report on and has, therefore, devoted its attention to standard apparatus in use by the various member companies."

Early reports of the Committee dealt with specific classes of equipment and current developments and practices related to prime movers. They were prepared by a growing number of subcommittees and supplemented by statements provided by manufacturers. Within 20 years the committee had been enlarged to about 70 members and the reports filled hundreds of pages.

Discussion of the many reports of the Committee naturally resulted in differences of opinion as the experiences of operating men brought new points of view and practical problems into focus. The Committee thus became a means by which operating experiences could be frankly discussed. Light on one operator's difficulties was shed by others who had faced the same or similar troubles. A "round-table" discussion of such experiences developed and became an important feature of meetings of the Committee. Eventually, questions were sent to the chairman of the round table in advance and were distributed by him to all members of the Committee. Discussion of these questions at Committee meetings brought forth useful answers, based on experience and specific in detail. New techniques, new equipment, new methods were reported freely. All gave of their experience and knowledge, all absorbed and benefited by what had been thus freely given. Nor did the process stop there. Manufacturers learned how their equipment was working out in daily operation. Consulting engineers and designers profited also. Ideas and equipment, tested on the proving ground of day-to-day experience and subjected to full frank discussion, had to be good to survive. Progress was rapid and widespread. Nowhere in the world had there been developed before, in so concentrated a field, a system by which any plant or any engineer could benefit so freely and quickly from the knowledge and experience of other plants and other engineers. Nowhere in the world had there ever been such close, such frank, such co-operative relationship between the men who design and the men who operate equipment. The result was, as Mr. Bailey points out, greater and more rapid progress in the power industry in this country than in any other.

When the NELA went out of existence and the Edison Electric Institute began its work in 1933, a Power Generation Committee of only 26 members under the chairmanship of Alex D. Bailey "planned to undertake the work formerly done by the Prime Movers Committee." In March, 1934, Mr. Bailey reported to the Operating Committee of EEI a need for an expansion of the personnel of his committee, and the Power Generation Committee itself discussed "enlargement of the committee to procure a more representative basis." The report of the June 5, 1933, meeting of the Power Generating Committee defined its scope as "a continuous study of the economics of power generation, including the various sources of power now used or in prospect, and the development and operation of mechanical equipment used for power production, including the study of fuels and their utilization in steam-generating equipment or in internal-combustion engines, the utilization of water power, the design, construction, and operation of power stations, the operating characteristics of generating stations, and the interrelation of various costs of generating electrical energy."

This main committee was divided into five principal study groups: Hydraulics, Norman R. Gibson, chairman; Steam Generation, Alfred Iddles, chairman; Turbines and Auxiliaries, E. B. Ricketts, chairman; Oil and Gas Power, Louis Elliott, chairman; and Binary Cycles, J. T. Barron, chairman. By 1934 the present Prime Movers Committee had emerged from these five groups and reference to the Power Generation Committee ceased.

In November, 1934, Alfred Iddles, chairman of the Prime Movers Committee, introduced the first report as follows:

"This Committee, under its scope, has oversight of all technical questions relating to power production except hydraulic power. Its concern is therefore with a great diversity of equipment in the steam-raising plant, the engines for final application of power to electric generators, and the auxiliaries and appurtenances thereto, as well as fuels, lubricants, and water supply. By reason of the variety and number of equipments and the circumstance that they are assembled into complete power plants no one of which is exactly like another, the accumulation and exchange of actual field experiences has a value that is greater, perhaps, than in any other technical department of the industry. This is reflected in the procedure of the committee where a premium is placed on actual experience that is applicable to similar but not precisely identical situations in other places."

Over the last dozen years the membership of the Committee has increased from 35 to something over 60. The present chairman, G. C. Daniels, describes the work of the Committee as it is conducted today in the following manner:

"The work of the Committee is handled through special subcommittees which are changed from time to time as the need for them becomes apparent and are dropped when the need ceases to exist. These subcommittees in general publish reports, either yearly or at two-year intervals, which have wide distribution and sale. These reports contain a brief statement of the trend and a summary of the report by the subcommittees. This statement is carefully edited and must have unanimous agreement by the Prime Movers Committee members before it is released. The reports usually contain data obtained from questionnaires sent to all members and also individual company statements which have been prepared for the Committee but for which the Committee assumes no responsibility. The manufacturers are also solicited for statements, which, however, are restricted to new equipment or unusual or valuable operating experience with their equipment.

"In addition to the subcommittees, numerous memberships on other national committees, such as those of ASTM, ASA, and ASME, are held by members of the Prime Movers Committee who bring their problems before the Prime Movers Committee and also keep the committee informed of the progress of the work being done by the other associations.

"In addition to the work of the subcommittees, the Prime Movers Committee conducts a round table devoted to the discussion of operating problems and unusual experiences. Questions for the round table are solicited several weeks before the meeting and are sent out to the membership in time to allow for the gathering of data for answering specific questions within their experience. During the past year the Committee has also been conducting a round table on design problems."

Dr. A. E. White, of the University of Michigan, who has been associated with the Committee since 1925, and looks upon that association as "one of my most valued contacts," has said:

"The Committee, through its work, has made most valuable contributions in the field of power generation. Free and frank discussions are held with regard to developments and to operating difficulties which have been experienced. These contributions have been of outstanding importance to the companies represented on the Committee. They have made it possible for various companies to forestall difficulties in plant performances and thus reduce costs in plant operation, with a resulting benefit to the public. Furthermore, the improvements which have been made in various plants with the aid of or at the suggestion of the various companies producing power-plant equipment have been reported by the companies concerned and have been adopted in many cases by other companies."

Dean A. A. Potter, of Purdue, who was a member of the Committee from 1920 to 1932 and has attended its meetings as a guest since then, says:

"This Committee is, to my way of thinking, one of the best agencies for bringing out faults in equipment and operating techniques of power plants in existence. Members of the Committee have always been ready to give to the others the benefit of their experience. Since the meetings of the Committee are not open to salesmen or representatives of manufacturers, the discussion is very frank, and has resulted in uncovering some serious matters, the correction of which has benefited industry and the public."

Such testimony ably supports Mr. Bailey's opinion that the Prime Movers Committee has evolved a method of procedure, typically engineering in its objectivity, which has resulted in more rapid advances in the power industry in this country than have been made in others where close co-operation of operators, designers, manufacturers, and consulting engineers has not been developed. As Mr. Bailey points out, the method can profitably be adopted and developed by other industries in this country; and it is not beyond possibility that it or its fruits might be a powerful factor in the rapid and sane reconstruction of a war-devastated world. Such a result might be a contribution of the engineers of this nation to the cause of internationalism, which is Mr. Bailey's thesis. In this connection, Colonel Cary's comments on the current accomplishments of Engineers Joint Council, quoted briefly on page 434 of this issue from a recent address, will be of interest and encouragement. With so fruitful a method and example as the Prime Movers Committee and with so representative an organization as EJC to spearhead the effort, engineers have an opportunity and a means to contribute to the peaceful settlement of the world's troubles.

The ENGINEER *and* INTERNATIONALISM

Power Industry in This Country an Example of His Effective Method of Approach

By E. G. BAILEY

PRESIDENT, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MANY people in the world today are in dire need of things which seem to be out of reach. It might be well to remember that at one time in the history of mankind practically everything now known as a part of our recent civilization, not only was out of reach but no one knew just how to get it. We pride ourselves in thinking that with accurately recorded history, nothing can be lost or even forgotten. Of technical knowledge that is undoubtedly true, but how about the spirit of man? Will this technical knowledge suffice if men do not have the spirit to work together to provide society with the things it needs but are seemingly out of reach?

We praise highly the spirit of man in rising above his environment in learning many laws of nature and mobilizing natural resources to his benefit. So goes history from the Stone Age, and with the aid of fire, through the Bronze Age, to the Iron Age. As man entered the Machine Age, he actively advanced the development of power. The discovery of electricity and the development of the internal-combustion engine have made power so extensively available that the entire Machine Age has been revitalized. This new development of energy, including both heat and power, has made possible extensive transportation and communications facilities and, in fact, has resulted in a new age of iron, steel, aluminum, and numerous metals and alloys. Even the industries of mining and agriculture have been mechanized to a high degree resulting in great relief from human drudgery.

The availability and use of power has done more to advance the living standards of mankind than has any other single accomplishment of the engineer. Yet developments in power have lagged in some parts of the world and are almost unknown in others.

Why has the power industry made greater progress in the United States than in many other nations? The technical knowledge has been available to engineers everywhere. Is there something in the approach of the engineer in the power industry in this country toward his problems that is responsible for his success? Can this method of approach be applied to other fields and in other nations? May not the engineer's methods of individual initiative and co-operative effort, working effectively toward a common and worth-while goal, be a vital force that is needed in many parts of the world if the best use is to be made of the material aid we hope to give them? Is not the application of this method of approach to problems one of the great contributions the engineer can make to internationalism?

An address delivered at the 1948 Spring Meeting, New Orleans, La., Mar. 1-4, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

POWER INDUSTRY TYPIFIES ENGINEERING METHODS

To enumerate only the principal fields in which engineering has helped and can continue to help mankind is a very long story, but the effective method the engineer has applied can be illustrated by reviewing briefly the history of our use of fuels and the development of our system of electric power generation. This history not only typifies engineering methods in general, but may possibly awaken in other parts of the world the spirit of accomplishment in a field so vital to the welfare of man, i.e., heat and power.

The generation and distribution of power from fuel involves a close co-operation of many branches of engineering and industry. How well each does its part, individually and collectively, materially affects the basic foundation of our modern civilization—the abundance of power at low cost. Secondary factors are the conservation of natural resources and commerce resulting from exchange of fuel and commodities between nations.

The production and utilization of fuel, such as coal, as a generic illustration, starts with geology, mining, and production and includes preparation and sizing, transportation, handling, and distribution, and then combustion—whether it be in the home, central station, locomotive, or steamship. The power process starts a new series of events, beginning with fuel-burning equipment, and following with the furnace and its burners, stoker, or pulverizers, boiler and steam piping, steam turbine, and electric generator. The distribution of electricity involves another chain of events which has been fairly well standardized.

The professions involved in this series of events include the geologist, metallurgist, and the mining, mechanical, chemical, and electrical engineers. Back of each of these are the equipment manufacturers with their engineers to invent, develop, and adapt the necessary mechanisms for mining coal and building power plants, locomotives, or ships. Finally and foremost, there is the broader composite talent known as the consulting engineer, who designs the power system and selects equipment for its operation.

SCIENCE, ENGINEERING, AND INDUSTRY

Modern industry throughout the world is largely the result of the efforts of the scientist, engineer, and industrialist, co-operating to produce economically that for which there is a demand or market.

The scientist and engineer discover and apply the laws of nature to our natural resources by developing methods and means for the industrialist to produce power, material things, and services for more people with less labor. Not everyone,

today, clearly comprehends the difference between "science" and "engineering." Perhaps this can be clarified by quoting Jevons: "A science teaches us to know, and an art to do, and all the more perfect sciences lead to the creation of corresponding arts. Astronomy is the foundation of the art of navigation. . . ."

James Watt analyzed the essential elements of the principles involved in the early steam engine, made certain deductions, and then, having practical ability and a desire to co-operate with others, proceeded to improve its design and build something which would work with greater efficiency. He did not worry as to whether he was a scientist, an artisan, or an engineer. In fact, he was all of these, as are many men today. Some choose to specialize and be labeled scientists, some engineers, and some industrialists.

So long as we maintain our free enterprise system and the pride of achievement, we may continue this advancement of the general welfare of mankind through the use of the creative ability of our scientists, engineers, and industrialists, and our available resources. The laws upon which we depend are universal, and even the psychological factor of getting the most out of them is capable of analysis and utilization toward the benefit of all who wholeheartedly co-operate.

THE ELECTRIC POWER INDUSTRY

Since the many conveniences available to all individuals in every walk of life are so dependent upon the use of electricity, we shall pass from the time of Watt, Stevenson, and Fulton, to the turn of the present century, when electric power was an infant industry of less than twenty years of age. At first the greatest demand for electric power came from street railways for urban and suburban transportation. Electric power consumption in the home and factory was very meager before about 1910.

Following closely on Thomas Edison's development of the electric light and other contributions involving the commercialization of electricity, the first power plants used the boiler and engine designed for the textile mill, but with the engine belted to an electric generator instead of a line shaft. Within a few years the belt drive was eliminated, and specially designed generators were directly connected to relatively slow-speed Corliss engines. The steam pressure gage, water column, and steam-engine indicator were the principal instruments for checking the performance. The over-all thermal efficiency of such plants was relatively low, about eight per cent, so that three or more pounds of coal were required per kilowatthour.

The largest and most efficient of the earliest plants were built for the Interborough Rapid Transit Company, New York, N. Y., under the general guidance of the late Mr. H. G. Stott, an active member of this Society. These stations are still operating, some of them using the original equipment, but they have been enlarged by adding more modern equipment as the years passed and expansion was required.

The important contributions of Sir Charles Parsons and Charles Gordon Curtis in developing the steam turbine permitted larger power units and higher efficiency through the possible use of higher steam pressures and temperatures.

The diversity of the problems previously mentioned demanded a wide variety of talent, ability, and experience of the men coming from marine and stationary power fields, as well as the graduates from the engineering schools. It also required, above all, co-operation of a high order. This co-operation extended not only between the men responsible for the design and operation of a single plant and electric system, but very quickly those engineers, who, having had experience in the design of one plant, formed consulting engineering firms to design plants for others, so that valuable experience was generously contributed to all. Information was exchanged through publications and discussions of technical papers in the technical press and the transactions of the national engineering socieites, which were then functioning and growing rapidly.

Phenomenal growth of a basic industry—power generation—involving so many new engineering problems, was accomplished through real ability and stamina of a high order, together with the knack of co-ordinating the efforts of many associates and suppliers of suitably designed equipment.

INFLUENCE OF THE PRIME MOVERS COMMITTEE

One of the principal reasons why the power industry is where it is today, and is still actively expanding, is that in 1911 the progressive operators of some of the larger plants formed the Prime Movers Committee. This committee is composed of representatives from the major operating companies. It holds two-day meetings four or five times a year. The members discuss frankly and freely the troubles and good points of their equipment. They sift out a true and fair diagnosis of operating problems and of performance of equipment. Oftentimes, if needed, corrections can be made on equipment already installed. Practically all operating data are available to the consulting engineers and to companies building new plants, and through them to manufacturers of equipment, so that everyone is on his mettle to acquire the most up-to-date knowledge and to apply it to new units, which follow in relatively rapid succession.

This procedure has already resulted in increased steam pressures and temperatures, improved efficiency, larger units, greater reliability, and wider adaptation of different fuels, especially low-grade coal, and oil or gas where geography and economics permitted.

The Prime Movers Committee exists today, and as a result of their activity the new central stations being built use still larger and more efficient equipment. For instance, a single unit comprising one boiler which generates 1,000,000 pounds of steam per hour at a pressure of 2000 psi and temperature of 1050 F and reheat is current practice. One turbogenerator produces 125-000 kw. Expected thermal efficiencies of 36 per cent are more than four times those of the earlier stations and exceed the probable efficiencies of the Diesel engine or the gas turbine using high-grade oil. These large and efficient steam-generating units use relatively low grades of coal which could not have been satisfactorily burned on the hand-fired or primitive stokers of 30 years ago. Now let us look at the progress of the power industry in Europe.

STATIONARY PLANTS IN EUROPE

A complete detailed comparison of European stationary power plants with those in the United States would require more time to present than is now available. A few high spots of conditions in Germany, France, and England will indicate the diversity of practice which has been followed by engineers, all of whom were entirely familiar with the experiments, developments, and practices in the United States and all other countries, including Russia, prior to about 1938.

Throughout all of western Europe pulverized coal was adopted in a number of plants shortly following the rapid progress made in the United States from about 1916 to 1923. By 1928 Germany had equipped several of its larger boiler plants with pulverized coal, using the bin system of the Cahokia-1922 design. However, German engineers diversified widely on some details of auxiliary equipment, and particularly pulverizers, the principal divergence showing the characteristic German method of trying or prejudging all kinds of pulverizers and then developing new ones, including the steam jet, the grindless mill, and still others prone to failure because a com-

plete study of the fundamental problem had not been carefully made.

By 1936 they had swung back to stokers of both the chain-grate and underfeed type in several new installations. During this time the use of stokers in the United States was largely discontinued, except in smaller plants where the spreader stoker has more recently been steadily gaining in favor. Practically no stokers of the spreader type were developed in Germany.

The Germans have advanced ahead of the rest of the world beginning in the 90's with the design of efficient by-product coke ovens, production of gas from coal, and problems involving economical processing of coal. However, their interest in the simpler problem of burning coal for the generation of heat and the production of steam was evidently not sufficient to inspire them to properly evaluate what was being done elsewhere regarding the best methods for generating power. Their interests seemed to go rather to trick boilers with forced circulation, such as the Benson, originating in England, or the forced-circulation boiler with return flow, known as the La Mont, originating in the United States, or the Loeffler, originating in Austria and developed commercially in Czechoslovakia.

The Germans never seemed to analyze the engineering, physical, and thermal problems with any accuracy in the original design, nor to work their way out of problems by empirical or cut-and-try methods. There seemed to be a lack of co-operation between the professor-engineer responsible for a design and the operators of the equipment. There was no equivalent to the Prime Movers Committee for co-operating in the sifting out of facts.

In France, Holland, and Belgium power development followed more closely a combination of the United States and British practice, rather than that of Germany.

In England, as in Germany, we find individualism of a high order, but there engineers followed partly the United States trend to pulverize coal, and then went back to underfeed stokers, but always keeping the chain-grate stoker on a larger percentage of the medium-sized plants than might have been best. They did not actively develop the spreader stoker, which was conceived there fifty years earlier.

In London and most urban centers England rightfully paid much attention to fly-ash and grit discharge from stacks. Two seldom realized factors differing from conditions in the United States are the lower average wind velocity and the higher average humidity, which, when combined with smoke and dust particles, result in most difficult fogs mitigating greatly against the use of pulverized coal without the introduction of expensive dust-cleaning and gas-washing equipment. Some British plants installed forced-circulation boilers of the Leoffler, La Mont, and modified Benson types.

DEVELOPMENTS IN POWER PLANTS

In the United States, as in the rest of the world, the first divergence in power equipment came between the fire-tube boiler and the water-tube boiler. Designs of both were developed very early in the history of steam throughout the world, but the problem was quickly analyzed and solved, with almost unanimous leaning toward the water-tube boiler for the higher pressures which were made possible with it.

The next important innovation was the steam turbine, which replaced the steam engine. That transition was made quickly and almost completely, except for locomotives, with very little controversy throughout the world.

A major step in power-plant design came when pulverized-coal firing superseded stoker firing in the larger units. Although confined to larger boiler plants, the battle between stoker and pulverized-coal firing raged quite fiercely through the 20's in the United States. Looking back at it now it was the old story of some taking the high road and some taking the low road, both following through until the advantages of the one over the other were proved to the satisfaction of all interested engineers.

The present active subject of further transition and progress relates to steam pressures and temperatures. While the answer will be reached logically from unbiased data and experience, the same answer will not apply economically to all conditions as to size, use, load factor, and fuel cost.

In the isolated industrial plant, such as in the chemical industry, where a process calls for a higher proportion of kilowatts than of steam in the form of Btu, engineers appreciated the advantages of higher steam pressures earlier than they did in the central-station industry. The Germans first perceived this. The British saw value in higher steam temperatures earlier than did the engineers in the United States.

In the United States the power plants are larger because the engineers appreciated the relation between size of equipment and cost per unit of output, which was an important factor in the rapid growth in the use of electric power.

DEVELOPMENTS IN LOCOMOTIVES

The steam locomotives of fifty years ago were in keeping with stationary and marine power plants of that day. As a matter of fact, they operated at about 100 psi higher steam pressure and produced more power per boiler than did other individual boiler units before about 1900.

Throughout the United States, England, and Europe, considerable effort has been made to improve the power and efficiency of the locomotive by the use of superheated steam, better valve gear, improved drafting in front end, fire-box arch, and mechanical stokers. Other more radical developments have been tried from time to time in different countries, such as the burning of pulverized coal in the conventional fire box, special high-pressure boilers, compounding of engines, and steam-turbine drive, without significant success.

Work is still being done, but in a rather discouraged, half-hearted way in so far as the steam locomotive is concerned. It is believed that the United States and many other countries having a basic coal economy should work more diligently on this problem. Possibly, the Prime Movers Committee method could be made to work better for the railroads than have some other efforts tried up to date.

DEVELOPMENTS IN MARINE POWER PLANT IN THE UNITED STATES

It was the early practice of shipyards to equip the ships built for both the merchant marine and the Navy with their own power-generating equipment, usually consisting of Scotch marine boilers and reciprocating steam engines. Later, water-tube boilers were introduced, primarily in the Navy, and, finally steam turbines. Practically all of this equipment was built in the shipyards.

The progress in the merchant marine was not as rapid as that of the Navy because the various operating companies did not have the equivalent of the Prime Movers Committee to exchange information as to the performance of the equipment which they purchased from manufacturers, according to the naval architects' or shipyard specifications.

The outstanding contribution in the marine field is that of the United States Navy. In fact, the Navy really led the progress in steam engineering for many years. Pressures of 300 psi and also turbine installations were standard practice in United States naval ships for some years before similar steam pressures and equipment were in general use in stationary practice. However, due partly to almost unlimited space and weight allowance, as contrasted with the rigid requirements of naval ships, stationary practice gradually passed and later far exceeded Navy

practice in the use of high-pressure and high-temperature steam and the machinery for its efficient utilization.

In 1892 the Navy, realizing the need for saving weight and improving the efficiency of fuel consumption, established a system for collection and comparison of operating performance, including efficiency, reliability, maintenance, and repairs.

During the first world war the Navy turned generally from coal to oil, based primarily upon the performance of a few vessels equipped with oil burners in 1912. Before converting to oil, the Navy conducted a series of very careful tests to develop suitable oil-burning equipment and to establish new methods of operation. Training schools were then initiated.

In the early 30's further advanced steps were taken to increase steam pressures and temperatures and to improve the design of all of the main propulsion equipment and auxiliaries of Navy ships in order to obtain the maximum possible efficiency.

As the equipment for higher pressure and higher temperature was studied, the manufacturers, used the experience gained with the central-station group, and applied it to the rigid requirements of minimum space and weight and other specifications of the Navy. Furthermore, all new or modified designs of boilers were subjected to complete performance tests up to full power and overload. These thorough studies and tests made it practically impossible for any equipment to be installed that was not designed and built to perform as expected. The beneficial results from such a program have been so thoroughly demonstrated by the experience in the last war that there can be no doubt that this method is largely responsible for the steam plants which performed in a satisfactory manner often operating over 250,000 miles without an outage or opportunity for maintenance, and without any deleterious effect on performance.

During the last war many ships of similar classes from the British and United States Navies had parallel tours of duty and fueled at the same stations. The oil consumption was noticeably lower on the United States ships, because of the use of the higher steam pressure and temperature, as well as other details of design relating to performance of auxiliaries, steam piping, and the like.

GERMAN NAVY

An unusual amount of information is now available through British Intelligence Objectives Sub-Committee[1] regarding the operation of the steam plants of the German Navy during the last war. Even to those who, prior to the war, had acquaintance with the German steam-engineering practice in stationary plants and the merchant-marine field, it was a surprise to learn that the steam-boiler-plant operation in the German Navy was so poor.

Quotations from this report follow:

> The new vessels of the German Battle Fleet have since the year 1934 been equipped with high-pressure superheater steam plants, which involved a considerable increase in steam pressures and temperatures over the wet-steam installations formerly used on German war vessels (270 psi to 1000 or 1800 psi, and from wet steam to superheated steam of 840 F).
>
> To ascertain the most suitable types of boiler, three boiler systems were tested: Benson boilers, La Mont boilers, and Wagner boilers.
>
> The first working tests were carried out with the escort vessels F.1 to F.12, the first half of which had La Mont boilers and the other Benson boilers. Before, however, the tests of these vessels were quite concluded, new vessels were put on order, namely, the destroyers 34 with Wagner and Benson boilers, and the torpedo boats 35 and Minesweepers (M Boats) 35 with Wagner boilers. These were followed by the battleships ***Scharnhorst*** and ***Gneisenau***, both with Wagner boilers, and the cruisers ***Blucher***, ***Hipper*** and ***Prinz Eugen***, with La Mont boilers. Only with the later vessels could the working tests made in the meantime be taken into account.
>
> All high-pressure superheated-steam vessels in service, especially the destroyers and 'torpedo boats 35, suffered from so many boiler and superheater tube troubles that scarcely one trip was accomplished without a boiler falling out—and this was invariably accompanied by a grievous loss of speed. . . . . . .The most serious situation was in the case of the Wagner (natural-circulation) boilers, where the tube damage had the effect of causing a splitting open of the boiler tubes (later referred to briefly as "tube ruptures") and in every case led to the immediate stoppage of the boiler.
>
> Superheater-tube damage followed later in increasing degree, involving very frequent, though shorter, interruptions in service.
>
> The statements of the different commands regarding the causes of the boiler damage were very contradictory. In most cases they were attributed to material defects. A minute inspection of the tube damage and systematic investigation of the causes was therefore indispensable.
>
> The damage and corrosion occurring in the Benson (once-through forced-circulation boiler without drum), and the La Mont (forced-circulation boiler with separating drum and return flow), were fundamentally of a similar nature to the damage in Wagner (natural-circulation) boilers.

The urgency of this situation called for the best talent available to take hold with power to act. According to there port, the engineers delegated with this authority were able to determine very quickly that the major trouble was not due to defective tubes but rather to inadequate feedwater treatment, a chemical function recognized throughout the world as a necessity in even medium-pressure boilers. They did not deaerate the feedwater, and the oxygen, normally always in solution in water, attacked and corroded the tubes at the pressures and temperatures used.

Further, in an overzealous effort to save weight the margin of safety had been reduced by the designers, resulting in localized high rates of heat absorption and reduced water circulation below safe limits on all types of boilers.

The record of improvements accomplished in the belated struggle to overcome their difficulties is interesting in comparing the failures on eight destroyers of the same class, four having Wagner boilers and four having Benson boilers.

NUMBER OF FAILURES

Destroyers	Boiler	Circulation	Year 40/41	Year 41/42	Year 42/43	Total failures
Z.4, Z.5, Z.6, Z.20	Wagner	Natural	62	23	6	91
Z.10, Z.14, Z.15, Z.16	Benson	Forced	89	95	52	236

From these data, it is noted that the failures of the Benson boilers were 44 per cent greater than the failures of the Wagner boilers during the first year's record. In three years, the rate of failure had been reduced 90 per cent on the Wagner boilers, but only 40 per cent on the Benson. The total record of 91 failures on the Wagner and 236 on the Benson boilers may be a great surprise to many people in this country who have been emulating or recommending to us the methods of the German scientists and engineers.

In addition to the boiler design itself, fuel was burned very poorly, partly because of inadequate burner designs. The Germans had ready access to all of the types of oil burners being used elsewhere, but used their own Saacke rotary-cup burner, which they presumed to be superior to the almost universally used pressure-atomizing burner.

The quality of fuel oil available was constantly deteriorating, and from the Ebano oil originally available they used mixtures of tar-oil derivatives, gas oil, and Esthonian shale oil, all of which contributed to poor combustion.

In short, practically everything involved in the modern de-

[1] The Activities of the Commission for Boiler Protection and Feed Water Treatment (KKS) for the Chief Commanding Officer of the Admiralty. H. M. Stationery Office, London, England.

sign and operation of boilers was found to be wrong in actual practice in the German Navy.

SUMMARY

Parts of this paper may not seem to be closely related to the title and the presentation may seem to be somewhat indirect, but it represents an engineer's approach to a problem involving some aspects of international psychology by stating facts and making pertinent comparisons.

Engineering is recognized as an exact science, but it is only after the laws of nature have been explored with sufficient thoroughness and open-mindedness that all engineers can agree upon the final conclusions as being factual.

When history shows that in the field of power generation, with the same kind of fuel being used to make the same kind of power, some, following certain methods, achieve much in efficiency and reliability, while others, following different methods, achieve neither efficiency nor reliability, there must be some explanation.

There is a human trait that shows up in all walks of life, viz., the pride of authorship. This is commendable to a degree, but when engineers are entrusted with the natural resources of our country or of our world, and have the responsibility of using them for the preservation and betterment of mankind, such opportunities and responsibilities must be taken seriously, and not interfered with by personal traits, likes, or dislikes.

Another human trait frequently evident is that when one surpasses others in almost any accomplishment we are all too often inclined to alibi by attributing the success to better opportunities or more fortunate conditions. It is true that "time and chance" often play a part, but under most circumstances the prize goes to the strong and justice finally prevails.

The Prime Movers Committee of the electric power industry is an excellent example of how a system of checks and balances has submerged the individual pride of authorship and success to the benefit of all, not by stifling it, but by encouraging it toward active competition with others. The rewards are engineering accomplishments, which enable each engineer or group of engineers to "see themselves as others see them."

The purpose of this discussion is to encourage serious study of a comparison of the natural resources, economic conditions, and educational methods—in schools, industries, and professional societies—in the United States and elsewhere, so that engineers everywhere will be familiar with, and be in a position to use, constructive ideas that have already been tried and proved by experience.

This brief outline of the development of the industries generating heat and power is illustrative of the engineering methods which have been fruitful in bringing about their present status. From this we may draw two main conclusions:

1 Power development may in like manner be extended more rapidly and economically in other fields and countries by following similar methods.

2 Similar methods have already proved sound in developing other industries and may be properly applied still further in the same industries and also into new fields of endeavor.

In order that there may be no misunderstanding about the method described in comparison with some of the present means which may seem to be the same, the method by which the power industry was developed in the United States was that of individual initiative and co-operative effort working effectively together toward a common and worth-while goal; the spirit of both teamwork and competition being continually rekindled through our system of reward and recognition for meritorious accomplishment.

Let us not be misled by some of the modern trends to start grandiose developmental projects in which the size of the appropriation and pay roll, and the false security of regimentation, form the apparent measure of importance and value of the objective.

As John Foster Dulles[2] has stated:

> Peace requires that the free societies be so healthy that they will repel communist penetration, just as a healthy body repels malignant germs. This is the only way to prevent communist dictatorships from so spreading that they will isolate us and eventually strangle us.
>
> How can that need be met? A rich nation, like a rich man, is apt to think first that its money can save it. No nation is so poor as a nation that has only dollars to give. We would, of course, have to provide money and goods. But the essential is that out of the physical vigor of our people and the intellectual stimulus of our free society should come the constructive ideas for which the whole world stands in wait.

The constructive ideas which are now available and waiting for others cannot be effectively used until there is a tuning in on the receiving end by dismissing many traditional deterrents and facing certain issues quite fairly.

Engineers should always freely and co-operatively strive toward the best economic answer regardless of national boundaries, whether operating on land, sea, or in the air. Engineers should also avoid unsound tradition, personal inhibitions, individual or minority interests, and seek to serve the majority, who are entitled to pay less money for more comforts and achievements, so long as all are willing to co-operate with others—their mutual neighbors.

Natural Gas

An increase of approximately two billion cubic feet of natural-gas capacity was added daily during 1947, according to an analysis of the growth and potentials of the natural-gas industry in the United States which has just been completed by the National Industrial Conference Board. This is part of a series dealing with the energy resources of the United States being made by the Conference Board.

More than 20,000 uses are claimed for natural gas. A few of these include three-range food-processing plants, open-hearth furnaces producing steel, glass works, and electric power generators.

Unlike the manufactured product, two thirds of which is sold for domestic use, the analysis points out, industry furnishes the largest market for natural gas. Whenever natural gas is used domestically it must be blended or diluted with other gas. Natural gas for cooking purposes would offer too intense a heat.

Natural gas, the analysis notes, accounts for four fifths of all the gas used today, and nearly one half of all the gas utilities' customers use natural gas. The remainder of the gas used in this country consists of gas manufactured from coal or oil.

Construction of new facilities during 1947 added 5370 miles of pipe lines, bringing the total network mileage up to 229,000 or about 2300 miles more than the mileage of trunk railroad tracks in the United States.

Marketed production of natural gas was valued at only $13 million in 1896. By 1919 the value of gas consumed had climbed to $161 million. On a physical-volume basis the marketed production of natural gas between 1911 and 1920 rose from about 513 billion cubic feet to about 798 billion, or a gain of 56 per cent. After the development of high-pressure pipe lines, however, marketed natural-gas production climbed, by 1929, to 1917.7 billion cubic feet, or 140 per cent above 1920. At the end of 1946 marketed production amounted to 4030 billion cubic feet.

[2] Address before the Foreign Policy Association of New York and broadcast over CBS Network, Jan. 17, 1948, "Not War, Not Peace."

TEACHING OUR WAY *of* LIFE

Program of ASME Engineers Civic Responsibility Committee for 1948

By F. A. FAVILLE

CHAIRMAN OF THE COMMITTEE

THE ASME Engineers Civic Responsibility Committee has arranged for many programs and articles in MECHANICAL ENGINEERING that have added greatly to the prestige of The American Society of Mechanical Engineers. To accomplish the aim of the Committee for 1948, it is important that the entire membership of the Society should be posted on the accomplishments of this Committee to date with recommendations for a definite plan of action.

The Engineers Civic Responsibility Committee and its advisory board are under the direction of the Board on Public Affairs. This Board supervises activities of the Society relating to co-operation with governmental agencies in engineering matters or international activities of importance to the engineering profession and the securing of larger participation by engineers in public affairs. Under direction of this Board, the Committee supervises the activities of the Society that are directed to securing larger participation by the sections and by individual engineers in civic affairs.

While all engineers subscribe to the recommendations of Congressman Hinshaw (1)[1] that more engineers are needed in public office, the particular appeal of the Civic Responsibility Committee for 1948 is to members who have no time or inclination to stand for public office. The support of such men is necessary to motivate the 1948 program of the Committee. In 1948 the Committee proposes to concentrate its efforts toward a single end, i.e., to arouse the interest of engineers in the importance of their own welfare in the principal public issue of the day—democracy versus collectivism. To achieve this end the Committee needs the support of members in planning programs to dramatize democratic ideals.

REVIEW OF ACCOMPLISHMENTS

Several years ago, The American Society of Mechanical Engineers recognized the necessity of focusing engineering thinking on the problems of making our form of government work in the complex industrial world of today. To this end the Engineers Civic Responsibility Committee was formed. Under the chairmanship of Roy V. Wright, past-president and Fellow ASME, this committee has accomplished much during the past few years of its existence. As an inspiration and guide for its work, it issued a manual, "The Engineers' Civic Responsibility," prepared and edited by Mr. Wright (2). Each year national and section meetings sponsored by the Committee gave reality to the ideal of civic service and brought home to ASME members the need of the engineer's service to the community. Addresses secured by the Committee have been published in MECHANICAL ENGINEERING (3, 4, 5, 6, 7, 8, 9, 10, 11). Truly, the activity of the Committee in the field of citizenship education has been a beacon light to follow which has been helpful to other societies and to the public. The Committee has served as a clearing house to bring to the attention of ASME members the numerous agencies at work to make our form of government and our way of life work. Few people appreciate how broad is the scope or how many millions are being spent simply to sell America back to the Americans.

SOME PROGRAMS FOR IMPROVING UNDERSTANDING NOW IN EFFECT

The results of various surveys show that 38 per cent of the people of this nation favor some form of collectivism, and that 67 per cent do not even want their sons to enter politics (12, 13). Such surveys have so alarmed American industry that large sums are being spent for the purpose of improving public understanding of the nature of our form of industry and of our form of government, and of improving understanding in the community. Money for these programs can be appropriated only after a thorough study of all methods that will produce practical results. It is a large assignment to bring to the attention of ASME local sections specific suggestions from those plans which have been tried and proved over a period of time and have definitely shown value in improved community understanding. In addition, suggestions must be such that they can be fitted into ASME meeting schedules.

Willys Overland had on display at the 1947 ASME Annual Meeting at Atlantic City a graphic exhibit which they employ to advantage to illustrate by simple visual means the economic workings of industry and even of a family budget. The idea is to make these matters so simple that anyone can understand them. Descriptive bulletins are available from the company and the display is widely used at meetings. The exhibits were created by James D. Mooney, member ASME, president Willys Overland Motors, and Walter Fried, consulting engineer.

Life magazine's panorama, "The New America of 1947," appraising America's economy, its industrial capacity, and its spirit, was another feature at Atlantic City, as it has been at the annual meeting of the American Petroleum Institute (14) and others. It is another graphic effort to sell Americans America. *Time* magazine is currently tabulating data on the U. S. college graduate which will appear in book form this spring (15). *Fortune* magazine ran a series of five supplements on "The U. S. in a New World," (16). It is interesting to quote the conclusion which they reached:

> "If Americans are to get the most from the American ideal—(our conception of a republican form of government)—*they must take some of it back to themselves*. This means that they must *take it back to where they live*, back from Washington to the 48 states and 3000 counties, and 35,000 *cities, towns, and villages* of the U. S."

Another phase of communications currently employed to improve understanding is the General Motors "Your Land and Mine" radio program—the largest hookup on the air today. This is supplemented by reprints supplied by General Motors.

Similarly, Sun Oil Company engages Felix Morley to talk on "International Affairs." Many other such efforts could be cited. Obviously, such plans are beyond our horizon financially and do not fit into any existing ASME activity.

Northwestern University's "Reviewing Stand," the University of Chicago's "Round Table," "Town Meeting of the Air," and similar programs all attempt to stimulate public thinking

[1] Numbers in parentheses refer to similarly numbered references at end of this paper.

on present-day issues. By allotting half of the time to each side of a problem, these programs often have the effect of a debate and result in unduly influencing people to only one side of the argument. A debate attempts to obtain a yes or no answer to a problem. In a discussion group, on the other hand, all sides of a given problem are frankly discussed to the end of arriving at a common solution and not a yes or no answer. Members do not line up on two sides as in a debate, and minority opinions are heard, but only in proportion to the percentage of the minority. We have a satisfactory form of government. Why allot one half of such discussions to promoting the advantages of some other type?

In England, people have abandoned newspapers to obtain current information from numerous news services, and many such are popular here—Kiplinger, Pettingil, "Human Events", Harding College Monthly Letter, Foundation for Economic Education, "Opinion Digest," *Readers' Digest*, and others too numerous to list. The January 19, 1948, *Chicago Tribune* gave Harding College a five column write-up under the heading, "College Is Champion of U. S. Way." This was headlined on the front page, second only in importance to the headlines on crime. (We are gaining in prestige!) In a continuation of this series, it is announced that MGM Pictures, Inc., will distribute a college-produced picture called "The Secret of American Prosperity," extolling the American way of life, a part of Harding's national education program now reaching 25 million people a week with a similar message. "The response," states President George S. Benson, "only confirms what I've always firmly believed—that there are plenty of good, staunch, patriotic Americans everywhere in this country." This manifests progress in both press and movie communications.

THE DISCUSSION MEETING

From many sources come favorable reports of the discussion method of improving understanding. In a two-issue editorial, the *Christian Science Monitor* comments on the program of the Standard Oil Company of New Jersey (17):

> An article in the current issue of "*The Lamp*" [S. O. of N. J. magazine] should be required reading for many businessmen and corporation heads . . . For a discussion of the art and theory of discussion to come out of a big petroleum company's house publication seems something to write home about . . . The economic importance of discussion groups lies in the fact that they mitigate economic as well as social tensions . . . With technical specialization, members of industrial society have lost personal touch with or emotional understanding of each other. Twentieth-century methods of production became dependent on horse-and-buggy-age methods of face-to-face communications . . . Discussion groups . . . appear to be one fast developing technique of replacing the fallen lines of social communication."

Here, obviously, there is much to be learned by adopting the programs proved by industry for use in local section meetings. In the discussion meeting, each speaker is admonished to cover only one thought when he talks, and no one can monopolize the discussion because three people must talk before the first speaker can comment again. The spirit of friendly discussion prevails, and there is no overemphasis on either side of a problem as in a debate.

Under the able leadership of Robert L. Johnson of Temple University in Philadelphia, the problems of peace were discussed in group discussions by over 600 participants in 1942. So outstanding were the results that the Citizenship Commission of the American Association of Colleges sent out the published transactions as their yearly report (18). This contains specific instructions for the conduct of discussion and the advantages of this type of discussion in attaining the benefits of the thinking of an entire group.

In like manner, this type of meeting has been employed to better community understanding in Peoria, Ill., and has enjoyed continued success over the past eight years. Here equal numbers from labor, management, agriculture, and the clergy make up the group. As L. J. Fletcher expresses it, they discuss "hot subjects with cool heads"(8). Misunderstandings are corrected. Community spirit and friends are the end product. These meetings are now on the air. The Illinois State Chamber of Commerce now has this plan operating in 98 counties of Illinois. Rules for organizing and running such meetings are ably described by L. J. Fletcher (19).

What are some of the elements that have made this type of meeting so popular that it has spread to every community where the Standard Oil Company of New Jersey operates (20)?

Will this type of meeting improve interest in local-section meetings?

ADVANTAGES OF GROUP DISCUSSIONS IN SECTION MEETINGS

1 *Interesting Meetings*. Even Phil Swain, editor of *Power* magazine, commenting on interesting meetings, admonishes us to "Go thou to an engineering meeting, and then go and do otherwise." Young engineers feel strange listening to a technical presentation by a recognized national authority. It becomes a meeting of the high authorities, where the timid soul feels like the uninvited guest. Rarely does the average member serve as chairman or even contribute in the discussion. This hurts both meeting attendance and member interest in the ASME. If, on the other hand, even a portion of such meetings is devoted to group discussions of pressing public issues, every member present is interested and has individual ideas which he will wish to expound. Such "Forums" have been conducted by the ASME Metropolitan Section for many years. Group discussions are fun. Everyone becomes a "part of the act." The timid soul is made to feel that he "belongs" to the group. He realizes that he is not helpless as an individual and that his ideas contribute to the thinking of the group. He will want to come to the next meeting.

2 "*Conference Manners*." ASME membership must stimulate growth of the individual—enough growth to be reflected by increased pay checks. Standard Oil Company of New Jersey realizes this sufficiently to publish a bulletin entitled "*Conference Leadership*" (21). The growth in understanding of conference manners brought about by participation in group discussions will be of tangible business value to every participating member on his job.

3 *Ability to Talk*. Nowhere is the engineer more lacking than in his ability to effectively express himself on his feet before an audience. Many members are called upon for short statements in discussion. It is the most effective training for the member to see his own progress in stating ideas concisely and effectively in order to gain acceptance by other members of the group. This affords him a "dress rehearsal in a friendly atmosphere." Such practice improves the ability to think logically, express effectively, and overcome natural timidity.

4 *ASME Prestige*. Papers of a highly technical nature have little appeal to the press, as only a narrow cross section of the public is interested. However, opinions resulting from group discussions of such subjects as "What are the most important national issues for 1948?" are of interest to a large cross section of people and as such will receive more extensive press notice. Truly, "The things which we discuss today become the political issues of tomorrow."

A great awakening is taking place by the press to its responsibility for the thinking of the people. "The engineer's creative thinking, the engineer's logic, and the engineer's accomplishments are the sinews upon which this country must depend" (22). This thinking can be articulate and will be welcomed by the press. An old Latin saying literally

translated says, "Who knows, but cannot express it, is lost as if he never possessed it." Give the crime boys some competition for press space.

5 *Program Aids for ASME Meetings*. There are many ways in which discussions of pressing issues can be dovetailed into local-section meetings. B. A. Lininger reported at Atlantic City how the Wilmington Subsection is utilizing discussion of public issues during the dinner period in their meetings. L. J. Fletcher has reported how the Central Illinois Section utilizes the idea of a "coffee speaker" following dinner before presenting the technical paper of the evening. Many entire evening meetings have been devoted to a discussion of the civic-affairs program, but too much has been left to the speaker and too little has been given to implementing such ideas into action. The group-discussion method lends itself admirably to such a purpose. Our program cannot be counted as successful until the Woman's Auxiliary groups show enough interest in such activities to introduce the subject in their meetings.

6 *Catharsis* plays an important role in the process of making healthy minds healthier. Dr. Albert N. Mayers, noted army psychiatrist, reporting on a number of discussion groups conducted by the New York Education Council states: (23)

> On one occasion the discussion from a settlement house was rebroadcast to Europe as part of this country's propaganda. This particular discussion group was chosen for the purpose simply because participants were so sincere and earnest about the opportunity to demonstrate how positively they believed in democracy that anyone listening to the program would indubitably be impressed with what was said and done.
>
> These participants identified themselves with something great. They saw that what they were doing was the sacred privilege and opportunity of all Americans. This challenge went deep into their personalities and carried a healthy emotional appeal that is seldom seen in either individual or group therapy. If there is such a thing as a national unconsciousness, these folk were surely satisfying that part of their psyche. The patriotic appeal cannot be underestimated in providing an important and significant contribution to the mental health of these individuals. Without doubt, the more numerous this type of discussion group, the less will the psychiatrist find individuals suffering from boredom, lack of purpose, a feeling of not belonging, and feelings of guilt that they are not doing enough. The discussion group can and does provide an outlet. It is a good therapeutic approach to many of the mental ills found in our country. If for no other reason, such discussion groups should be continued and initiated elsewhere as a mental hygiene procedure.

7 *That Letter to Your Congressman*. We hear much—far too much—of the famous admonition, "Write your Congressman." What if everyone actually did it? How much time would a poor Congressman have if his fan mail totaled 140,000,000 letters? In this nation of 140 million souls, we must develop a more businesslike method than this to post our legislators on public opinion. We must devise better ways to make the thinking of educated groups—of thinking groups—available to the legislator. The legislator is like a corporation director; he must act by proxy for the absent stockholder. The membership of the local section is representative of engineering thought. Means must be devised to make this thought articulate, available for guidance of the legislator. The engineering mind, with its inherent quality of integrity, can put debatable questions in understandable form. In no other profession has the public greater confidence. No other profession is trained in analysis and synthesis to accomplish assembly into a co-ordinated whole. Where is the legislator to obtain more unselfish or more thoroughly reasoned opinion? It is the ideas of men in the upper salary brackets, who are too preoccupied to write their Congressman on the multitudinous problems before legislators that we must make articulate. Opinions arrived at in group discussions accomplish just this. Joseph Cahn (24), director of discussion project for New York Adult Education Council, reports the conclusions of one such discussion:

> At least one group said it put greater faith in group action than in communications to Congress, though several groups did communicate with local, state, and federal officials.

ASME MEMBERS' INTEREST SOLICITED

The biggest problem facing the Society is stimulating an interested spirit in its members. To a large measure, this must be done at local-section meetings. The Society wants section activities to be autonomous. Technical discussions of necessity are flavoured by commercial considerations. There are no limitations on any individual in discussions of pressing public issues.

We must have interesting meetings for society vitality. These are selfish Society aims, but with an altruistic purpose. ASME membership involves being a part of the greatest society, of the greatest nation of the world. Thus we bear a terrifying responsibility. We owe it to ourselves and to the rest of the world to develop a social and economic health such as no other nation can attain under any other system. In the relay race of civilization, it is our turn. We are handed the baton. No one can carry it far, but make sure each of us carries it ahead a bit—in the *right* direction.

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STABILITY *of the* ATMOSPHERE *and* ITS INFLUENCE *on* AIR POLLUTION

By HENRY F. HEBLEY

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HOW often has the thoughtful observer pondered the apparent contradictions experienced in the weather?

One can take the records of two days, one in the winter and one in the summer. The "degree days" indicate that space-heating and domestic load was present in one case and not in the other. The business index may be about the same, indicating that the industrial activity of the area and the amount of fuel used were about the same. Thus the volume of the products of combustion released to the atmosphere varied only as related to the space-heating demand.

Yet on one day in winter the atmosphere may be clear and bracing, while on a summer's day the air is thick and murky and the visibility sharply reduced. Or the situation may be reversed. What are some of the factors that contribute to the creation of these conditions?

These few notes have been prepared to indicate some of the influences that are exerted on the problem.

THE SOURCES OF ATMOSPHERIC POLLUTION

The industrial area of Pittsburgh, Pa., has been a dominant center for the production of iron and steel for more than one hundred years.

In addition, the type of manufacture carried out in this area is predominantly dependent on thermal energy (heat). That energy is supplied from coke and coal produced in the vicinity of Pittsburgh.

It is estimated that the metallurgical industries of the Pittsburgh area consume between 35 and 40 million tons of coal annually.

In the burning of this vast amount of fuel it must be remembered that, no matter what adventures the gases of combustion experience as they pass through the various processes, ultimately the spent gases are discharged through chimneys to the atmosphere and constitute a major source of atmospheric pollution.

TOPOGRAPHY OF PITTSBURGH AND ENVIRONS

The development of the Pittsburgh area as a center of heavy industry rests on a number of favorable circumstances:

(*a*) Good coking coal, yielding a strong metallurgical coke low in sulphur content.

(*b*) Adequate supplies of limestone for fluxing.

(*c*) Economic water-transportation arrangements for exchanging ore from the iron-ore fields and solid fuel from the coal fields.

These very advantages, however, are accompanied by difficulties of topography associated with the steep valleys of the Allegheny, the Youghiogheny, the Monongahela, and the Ohio Rivers. These natural conditions create local climatic situations that affect air pollution and warrant earnest consideration. Moreover, these conditions have been augmented by human activities through the location of rail and river transportation practically at the river level, together with the concentration of industry within the confines of the narrow steep valleys.

It may be of interest to observe that many of the centers of heavy industry are similarly situated: Youngstown, Ohio, in the Mahoning Valley; Johnstown, Pa., in the Stony Creek Valley; Wheeling, W. Va., in the Ohio Valley; Sheffield, Yorkshire, England, in the Don and Sheaf Valleys; and Liege, Belgium, in the Meuse Valley. Incidentally, all of these cities have atmospheric-pollution problems very similar to those associated with Pittsburgh, although Sheffield and Liege, because of their proximity to the ocean, experience a maritime rather than the continental type of climate which prevails in American cities, except those west of the Rockies.

From a study of the contour map of the Pittsburgh industrial area under consideration it will be noted that the steep valleys form convenient conduits through which atmospheric pollution may flow by air drainage from the numerous industrial centers situated in this Ohio River drainage area.

WIND AND AIR MOTION

In such broken terrain with steep hills and valleys running in many directions, the local air movements in the lower layers are extremely complex. At the higher levels, for the most part, wind movements have a westerly component. These great westerly air movements are very steady. However, under such local interference of terrain as is met with in the Pittsburgh area, the disturbing influences are very great when compared to those encountered in the cities of the plains.

The air-drainage system that is present in the Pittsburgh area is quite apparent to those who have taken pains to study the local air flows of the lower atmospheric layers as they are encountered in the Monongahela, Allegheny, and East Ohio drainage area. No description of the deeply complicated air movements in such local terrain can excel that given by T. Morris Longstreth in his book, "Knowing the Weather." (1)[1] He states: "Below an altitude of 600 feet the wind proceeds in an unpictural turmoil. Friction with field and wood and hill forms an irregular drag upon its undermost layer. The over layers stub their toes, stumble forward, fall down, turn somersaults, make mill wheels, make spinners, fluctuate in velocity, rush and crowd, and pick themselves up and go on. The vertical convulsions of wind are less rapid but just as intricate."

Superimposed on these local fluctuations are the steady air flows of the air-drainage system down the tributary valleys into the main valleys of the Monongahela, Allegheny, and Ohio Rivers. Provided weather conditions are conducive, cooled air will flow into the air-drainage system from as far afield as Morgantown, W. Va., on the Monongahela, New Kensington on the Allegheny, or New Castle on the Beaver River.

When the sloping surfaces of the sides of valleys radiate their warmth to the universe on clear nights, the ground temperature drops and the layers of air touching the ground are in turn

Contributed by the Fuels Division of The American Society of Mechanical Engineers and presented at the joint AIME-ASME Fuels Meeting, Cincinnati, Ohio, Oct. 20, 1947.

[1] Numbers in parentheses refer to similarly numbered references at end of this paper.

cooled and begin to slip down into the valley and drain into the valley system.

Such air-drainage movements manifest themselves as cool breezes issuing from the mouths of valleys where they join the course of the main rivers. In the area under consideration, even though fog and mist have accumulated in the main river valley reducing the visibility to zero, the captains navigating the river craft are well aware when they are abreast of the valley of a tributary because of the cool drafts that can be felt.

Such winds are known as "katabatic" or downhill winds, and although they are comparatively faint and gentle in this area they have been known to reach a velocity of 200 miles per hour as they sweep down the snow-covered slopes of the plateau of Greenland toward the sea.

Closer consideration must also be given to the vertical air movements previously mentioned.

PHYSICS OF AIR MOVEMENTS

In any study of the problem of atmospheric pollution the influences of the turbulence and stability of the air are of paramount importance. These conditions are related to the general air-drainage movement previously mentioned; but some of the local factors and terrain exert effects that greatly modify the final results.

In a fundamental study of air movements it must be borne in mind that gases are far more free to move than liquids. In addition, gas when heated expands and thus its density is decreased.

Many examples of this fact may be recalled, but possibly the draft of the common chimney is the most apt illustration. In this device the air for combustion is warmed, experiences a reduction in density, and is pushed upward by more dense (heavier) air entering at the lowest point, generally under the grate of the furnace. Another homely example is the gravity warm-air furnace used in the space heating of homes.

Consider the heating of the earth's surface by the sun as it is affected by absorption of heat or insolation. Because of numerous influences, the surface is very unequally heated. As a result, the layers of air adjacent to the earth's surface, which are heated by conduction from that surface, receive very unequal amounts of heat. Such unequal heating of the atmosphere in contact with the ground results in upward and downward convection currents of air between ground areas of different temperatures.

Adiabatic Lapse Rates. At this point it may not be amiss to introduce the conception of "adiabatic" changes in temperature. Turning once again to Longstreth and his book "Knowing the Weather" there will be found the following simple definition:

"The word adiabatic is applied in the science of thermodynamics to a process during which no heat is cummunicated to or withdrawn from the body or system concerned. Adiabatic changes in temperature are those that occur only in consequence of compression or expansion accompanying an increase or a decrease of atmospheric pressure. Such changes are also described as dynamic heating and cooling."

The atmosphere, because it is a gas, can be compressed or expanded, and the layers of air close to the earth's surface are compressed by the weight of the atmosphere above them.

In accordance with Boyle's law, if any parcel of ascending air reaches a higher elevation and lower pressure it will expand. Such expansion is work done and the energy required to perform that work is derived from the heat contained in the air. This action results in the cooling of the parcel of air.

If, however, the air sinks to a lower elevation, it is compressed and is thereby warmed. These temperature changes, it should be noted, are accomplished with no addition or subtraction of heat from the parcel of air under consideration. They are adiabatic changes. Fig. 1 is suggestive of the action.

In a dry atmosphere when a parcel of air ascends the dynamic cooling caused by its expansion is practically uniform and falls at the rate of 1 C per 100 meters of elevation (5.5 F per 1000 ft). This relationship is known as the dry adiabatic lapse rate.

It is well known, however, that the atmosphere has associated with it varying amounts of water vapor. If a goodly percentage of it is present in the ascending air, the cooling due to expansion may bring the air to 100 per cent relative humidity or saturation. At that point some of the water vapor will condense and form liquid droplets. In so doing, the latent heat is released to the air, thus retarding the rate of cooling.

If the parcel of air continues to rise, additional water vapor will condense, releasing further heat, and the air will be cooled at a "saturated adiabatic rate," also known as the retarded, wet, or moist adiabatic lapse rate.

This rate of cooling is further complicated by a number of influencing factors, such as pressure and temperature, and whether the liquid accompanies the parcel of air on its journey or is left behind.

Under different conditions the moist adiabatic rate varies from approximately 0.4 C to nearly 1.0 C per 100 meters, or 2.2 F per 1000 ft to nearly 5.5 F per 1000 ft.

If actual data are not available, it may be convenient to assume a moist adiabatic rate of 0.6 C per 100 meters (3.2 F per 1000 ft).

The ability of the atmosphere to carry water vapor increases

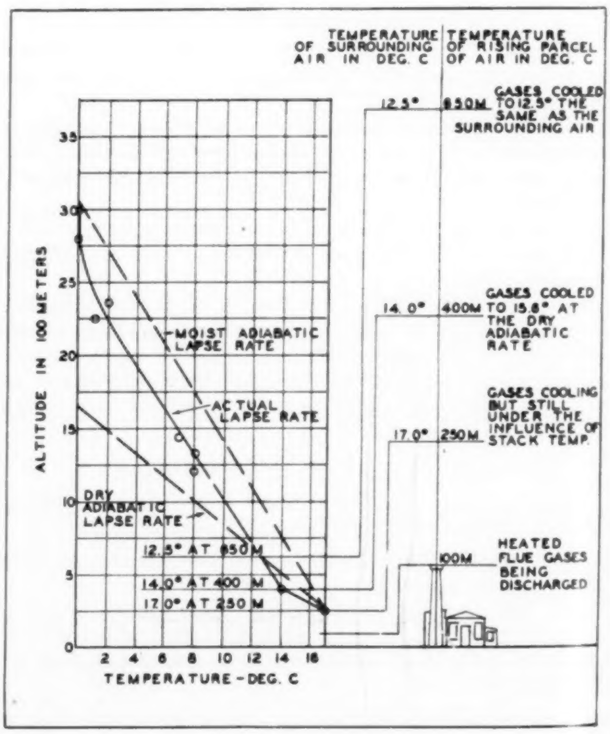


FIG. 1 THE STABILITY OF AIR

[A rising portion of air cools at the adiabatic rate provided it does not reach its dew point. A descending portion of air warms at the adiabatic rate. If a parcel of air gets a *push* either up or down, then on the foregoing conditions of atmosphere the parcel of air keeps either rising or falling. *The air is unstable.* The *push* is frequently given by a change in temperature. If air is heated near the surface of the ground (stacks, chimneys, etc.) and starts to rise, it will continue to rise as long as it is surrounded by air having a temperature gradient greater than the dry adiabatic. Air is unstable when its lapse rate is greater than the dry adiabatic rate. This condition is favorable to convection.

with a rise in temperature. Therefore air, if it is descending, is enabled to carry more moisture as it is compressed. As a result, there will be no condensation. If there is liquid in the parcel of air, some or all of it will be evaporated into water vapor; but in so doing, latent heat will be drawn from the air and the warming effect due to compression will be retarded by the latent-heat requirements.

If all the water vapor contained in the ascending parcel of air continued to be associated with it and then descended again, the retardation of the rate of cooling would be the same as the retardation of the rate of warming during descent. However, if the moisture has been precipitated, the parcel of air on its descent will increase in temperature at the "dry adiabatic rate."

Even though condensation has taken place, there may be some liquid present when the air begins to descend; but this changes to water vapor as the temperature rises, and after that condition has been reached, a continued descent of the air is on the dry adiabatic basis.

The discussion so far has dealt only with the changing temperatures of a parcel of air because of the varying pressures due to altitude. However, many influences act frequently to cause the air to depart radically from the foregoing rule. Strong movements of horizontal air currents in the Pittsburgh area frequently sweep in from the northwest or southwest, bringing cold or warm masses of air. In addition, air may not be ascending or falling. Consequently, it will not be changing in accordance with the adiabatic rate. Also the atmosphere is continually gaining or losing thermal energy by conduction, absorption, and radiation. Therefore the various temperatures encountered at different elevations often show a marked deviation from the adiabatic rate.

Change of temperature with altitude is referred to as the "lapse rate." It implies the passing from a higher to a lower temperature. Where a stratum of warmer air is encountered and the temperature rises, the lapse rate is considered negative.

In actual experience, the atmosphere over a local area may have lapse rates that vary greatly on consecutive days. Also, there are variations in the lapse rates at different levels of the atmosphere during 24 hr. This condition is especially true for the first 11,000 ft from the surface of the ground. Above this elevation the lapse rates are likely to be more uniform.

It is in this 11,000-ft band of atmosphere that the temperature changes are very irregular and are modified by variable wind movements, gusts, eddies, and the like, caused by valleys, hills, and bodies of water, etc. At times these local effects create a temporary lapse rate that is in excess of the dry adiabatic rate. Conversely, the lapse rate is frequently less than the moist adiabatic rate.

Inversion. An actual increase in air temperature with increase in altitude is known as an inversion of the temperature gradient, or simply an inversion.

When such an inversion condition exists, the inability of the lower layers of the atmosphere to rise keeps them in a stable condition. After sunset on clear starlight nights with very gentle wind movement the surface of the ground cools rapidly by radiating its heat energy to the universe.

The lowered ground temperature influences the adjacent 10 to 20 ft of air causing it to fall below the temperature of the higher air strata. Fogs known as radiation or ground fogs are frequently caused by this inversion condition provided other atmospheric factors are favorable to them. On the other hand, at the higher levels, wind movements from different directions and having different temperatures may create an inversion.

As previously mentioned, a convenient assumption for the moist adiabatic lapse rate is 0.6 C per 100 meters (3.2 F per 1000 ft). This rate is also close to the average existing lapse rate as determined by many observations in different countries.

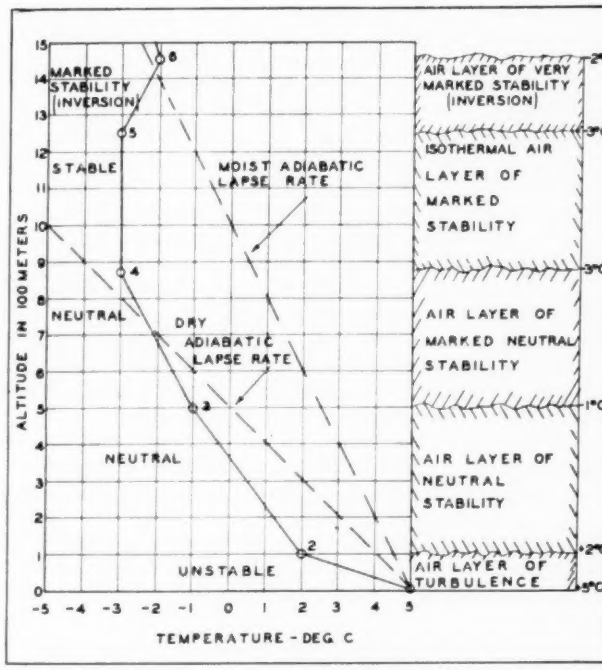


FIG. 2 TEMPERATURE LAPSE RATE WITH ALTITUDE, PITTSBURGH, MAR. 31, 1947, 11:00 A.M.

STABILITY OF THE ATMOSPHERE

From what has been stated, it will be realized that air movements are influenced by many factors that act in an extremely complicated manner. These air movements can be studied through the relationship of the lapse rates to the tendency of the atmosphere to descend, ascend, or stay in one position.

It may be profitable to consider these three cases in greater detail:

If a layer of air, say, 1500 ft thick, rests on the ground and has practically the same temperature throughout that height, the air against the ground will be the most dense (heaviest in weight per cu ft) because of the weight of the air column resting upon it. With no external influence this air will continue in the lower layers.

Now assume that some of this air is forced to ascend (possibly as chimney gases) through the surrounding air. It will begin to expand due to decreased pressure and, provided it does not reach the saturation point (RH 100 per cent), it will cool at the adiabatic rate.

Thus if it is still in the atmosphere of constant temperature, the parcel of air forced upward will be cooler and more dense than the air surrounding it. As a consequence, it will subside to its position at the surface. Such a condition may be suitably illustrated by atmospheric conditions that prevailed in Pittsburgh at 11:00 a.m., March 31, 1947, see Fig. 2. In the analysis of the particular day under study, some attention should be given to conditions close to the ground. These are presented graphically in Fig. 3. The air layer close to the ground surface, that is 100 meters up, on that day had considerable turbulence. The parcel of air *C* at 5 C, if given an initial push, possibly from some increase in temperature, will start on its way upward, cooling at the dry adiabatic lapse rate as it travels. After rising some 100 meters the temperature of the parcel of air *C* will have receded to 4 C. However, the surrounding atmosphere has a temperature of plus 2 C. Thus the air will continue to rise and "punch" into the layer of stable air resting above the turbulent layer.

A portion of the lapse rate for the next layers of the atmosphere is shown in Fig. 4. The line 1-2-3 is the actual plot of the air temperature at different altitudes.

It is of interest to ascertain the stability of the air.

The parcel of air A is moved up in elevation by one of a number of causes, say turbulence. It reaches the elevation A_2. Because of expansion due to decreased pressure, the parcel of air with a relative humidity of 46 per cent has cooled at the dry adiabatic lapse rate and has been reduced in temperature to —0.6 C. The actual temperature of the atmosphere surrounding the parcel A_2 is 0.0 C.

Thus the air parcel is cooler and therefore more dense and heavier than the surrounding air, and if it experiences no further interference, will sink back to its original position. (An atmospheric condition that creates this state is stable air.- In passing it should be noted that the air with a relative humidity of 46 per cent was in the unsaturated condition.

Had the parcel of air been in a saturated condition, its action may have been modified. If the slope of the 2-3 portion of the lapse-rate line 1-2-3 had been parallel to the moist adiabatic lapse rate (0.6 C per 100 meters) then the parcel of air would have dropped in temperature at the moist lapse rate and the air would stay where it came to rest. In other words, it would be neutral, as its changes would coincide with those of the moist lapse rate.

It so happens that in the higher layers a condition of marked stability known as an inversion of the normal lapse rate was encountered. (See Fig. 2, points 4-5-6.) Here the air actually became warmer than the layers below.

The extremely powerful ability to imprison impurities associated with the products of combustion as they are discharged into an atmosphere of such stable conditions has not been fully realized. It needs greater consideration.

In this case the prevailing conditions are of such marked stability that even if the relative humidity was such that condensation took place, the temperature difference would still be sufficient to hold the atmospheric pollution within bounds.

CONDITIONAL INSTABILITY

So far in this discussion, the conditions of the atmosphere were such that the influence of the "dew point" has not been a factor in the cases of stable and unstable air. All that has been shown is the tendency of the air to return to its original state and position, thus gathering the impurities created both by nature and man and holding them until atmospheric conditions dispel them.

On numerous occasions, however, the amount of water vapor associated with the air is a great deal more than the quantity encountered on March 31, 1947.

The lapse rate will follow the dry adiabatic line until the dew point is reached. After this, the lapse rate will follow the moist adiabatic rate which is retarded compared to the dry adiabatic because of the continual release of latent heat as the water vapor condenses into drops of liquid.

The foregoing discussion pertaining to the influence of lapse rates on the various layers of air has taken little account of convection and turbulence. On warm sunny days when the surface of the ground rapidly becomes heated the adjacent layers of air increase in temperature and begin to rise, causing convection currents, thus aiding in local vertical air circulation that is inherent during unstable air conditions.

In addition to this movement of convection there is the vertical component of air velocity brought about by wind or air in motion. Such currents of air do not require that the atmosphere be unstable in character. As described in the previous quotation from Longstreth, in the air layers adjacent to the ground the hills, valleys, and obstacles such as buildings, trees, and the like, cause local irregularities in the air movements. It results in an uneven reduction of the velocity of the ground layers and a downward sweep of the upper layers that are moving at a higher velocity. Such surges thrust the ground layers upward in an irregular fashion, giving rise to gusts of wind both laterally and vertically and a combination of these movements in an indescribably complex manner.

Such turbulence will carry the surface air layers to higher strata, causing appreciable mixing of the atmospheric impurities through a rather deep layer of the atmosphere and thus

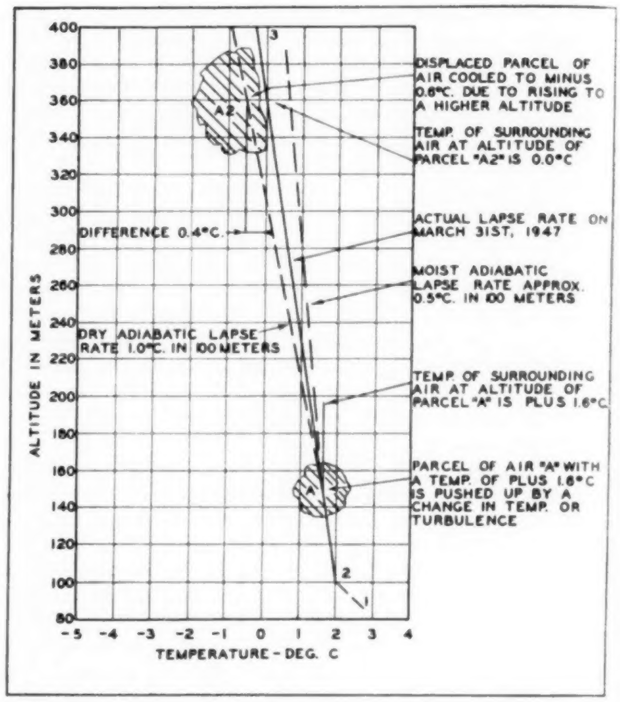


FIG. 4 ATMOSPHERE TURBULENCE—A LOWERED LAPSE RATE INCREASES STABILITY OF AIR

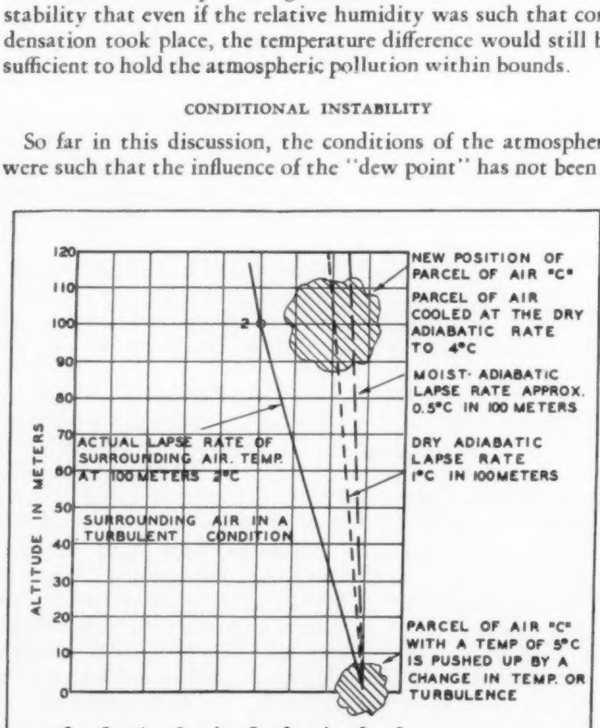


FIG. 3 ATMOSPHERE TURBULENCE—A HIGH LAPSE RATE CAUSES INSTABILITY OF AIR

diluting the pollution by distributing it through a vastly greater volume. Turbulence drops rapidly as the stability of the atmosphere becomes more marked, and where low inversion conditions prevail it is practically nonexistent, especially at the ground level where friction exerts its influence.

EFFECT OF TURBULENCE ON POLLUTION

The effectiveness of turbulence on the scavenging of the impurities from urban and industrial atmospheres must not be underestimated.

Up to the present we have depended on turbulence, convection currents, and air movement to cleanse the atmospheres of industrial cities. Most of the time atmospheric conditions perform that function rather successfully; but when the air movements fail, then the pollutants with their disagreeable attributes become concentrated.

The unprecendented growth of the world's industrial activities has aggravated the conditions, especially in cities whose growth has taken place through many decades with little or no city planning and with buildings concentrated in narrow streets interfering greatly with effective ventilation of the area.

Dobson (2) directed attention to the subject when he pointed out that although boisterous winds of high velocity will sweep out atmospheric pollution, the factor of turbulence is a powerful one in dissipating the pollutants. It is possible to have fairly rapidly moving winds but with slight turbulence. Such air motions may not be so efficacious as gentler winds that are associated with strong upward and downward air movements.

Dobson further indicated that many times the atmosphere at 1000 ft is moving at a far greater velocity than near the ground level and is relatively free of pollution. If turbulence is present, there is a ready mixing and dilution of the air impurities

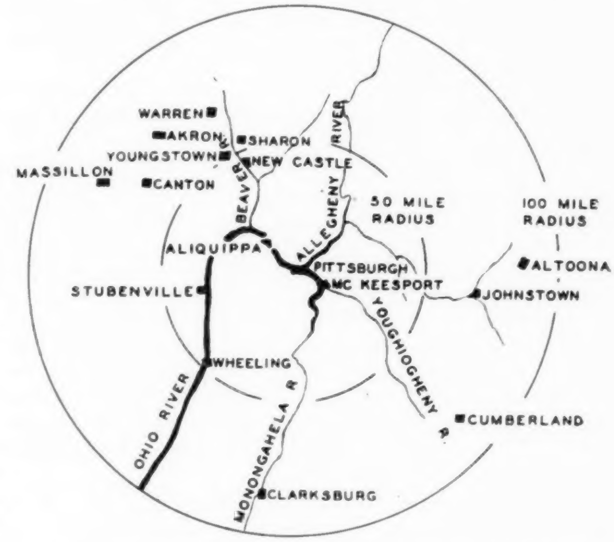


FIG. 6 POTENTIAL SOURCES OF AIR POLLUTION SURROUNDING PITTSBURGH, CITIES LARGER THAN 25,000 POPULATION

with this clean air layer that is just a few hundred feet above, rather than a general shift through the city area from windward to leeward, a distance in many cases of over 30,000 ft.

This condition has been mentioned by Meetham (3) who points out that the concentration of impurities in the central area of an industrial city is more or less constant no matter how the wind changes in its direction. Fig. 5 has been postulated for the Pittsburgh area based on Dr. Meetham's (3) analysis to indicate a possible distribution of atmospheric pollution when wind in its motions of translation moves the atmospheric pollution downwind. Naturally, each industrial center is a problem unto itself and should be analyzed as such; this diagram has been presented only to provoke thought on the problem.

Assuming the maximum concentration of impurity in the center of the city as represented by 100 arbitrary units of air pollution it will be noted that it trails downwind in decreasing intensities, but is still carrying 25 units 4 miles from the center of the city.

To the windward, appreciable concentrations are encountered one mile from the 100-unit concentration. If concentrations of over 70 arbitrary units are considered as heavy, it will be noted that in the hypothetical case assumed there is an area in the center of this city bounded by a circle of one-mile radius that will experience atmospheric pollution when the wind is blowing from any quarter. Such a postulate may be studied for the conditions of any industrial center as well as the proximity of other neighboring communities of industry.

In the case of Pittsburgh, the city is surrounded by industrial centers of 25,000 population or more. Fig. 6 indicates the problem of transported air pollution derived from exterior sources.

In order to convey some idea of the relative effect of wind velocity and atmospheric turbulence, Dr. Meetham has offered a numerical demonstration and has graciously permitted the use of the salient points of his analysis in this text.

"It is convenient to begin by imagining a row of cubical cells, in one of which there are 64 units of smoke. Diffusion due to turbulence may be represented by supposing that in one

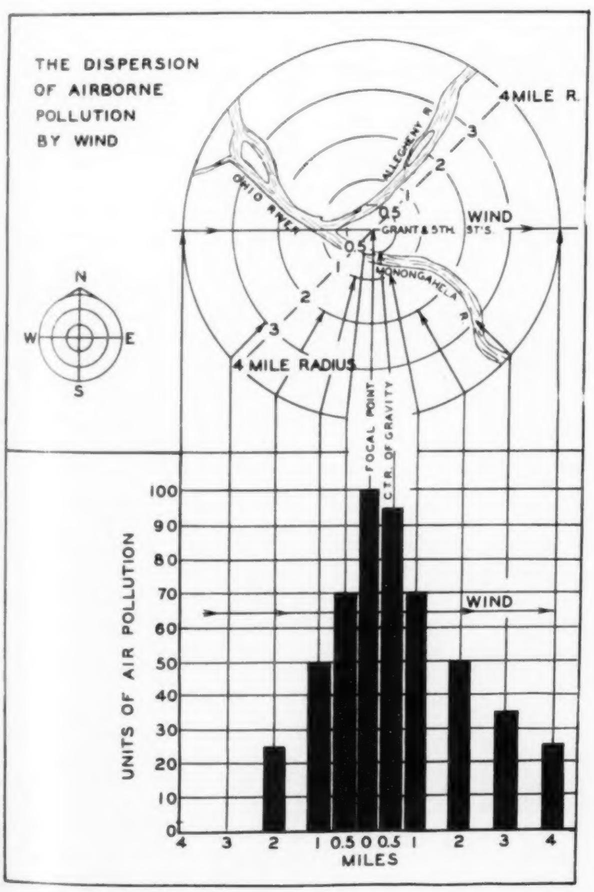


FIG. 5

second's time the smoke is divided equally vertically between two adjoining cells."

Fig. 7 shows the position of the smoke at successive time intervals of one second, due to turbulence alone. To take wind into account, suppose that a chimney emits 64 units of smoke each second into the cell (10-ft cube) immediately above it and that the wind velocity is 10 fps.

By an extension of Fig. 7 it can be seen that the amount of smoke in different positions downwind from the chimney top is given in Fig. 8.

It should be noted that no allowance has been made for horizontal diffusion and the figure best represents the effect of a row of chimneys placed across wind at right angles to the plane of the paper. A heavy line has been drawn enclosing all numbers greater than 15, which was selected arbitrarily. It represents the apparent outline of the smoke trail from a single chimney when it is viewed from one side by an observer who can detect 16 or more units of smoke in any line of sight.

In practice, smoke trails are never as steady as this because they develop waves due to large-scale turbulence. Another effect of large-scale turbulence is to cause a progressive increase in the rate of diffusion. Therefore Fig. 8 must be regarded very much as a simplified abstraction.

Fig. 9 shows the effect of doubling the wind speed. Every 64 units of smoke at the chimney top now has to fill two cells and the smoke moves along at twice the speed. The visible outline of the smoke is much reduced in area.

Fig. 10 shows the effect, with the original wind speed, of doubling the rate of diffusion due to turbulence. The width of the smoke trail increases rapidly at first and again the visible outline is much reduced in area. The actual results as presented in Figs. 7 to 9, inclusive, were based on the actual studies made at Leicester, England.

There is an interesting result if the concentration of smoke along the axis of the trail in Figs. 7 to 9, inclusive, are presented as in Table 1.

TABLE 1

Fig. no.	Wind speed, fps	Diffusion rate	Distance in feet from chimney top: 0	20	40	60	80	100	120	140	160
8	10	1	64	32	24	20	18	16	15	14	13
9	20	1	32	..	16	..	12	..	10	..	..
			(45)	(22)	(17)	(14)	(13)	(11)	(10)	(10)	(9)
10	10	2	64	24	18	15	13	12	10	10	9

The figures shown in parentheses were obtained by dividing the top row of numbers by the square root of 2.

Their agreement apart from the irregularities at the chimney top with Figs. 9 and 10 suggests that doubling the wind speed or doubling the rate of diffusion due to turbulence, reduces the concentration of smoke in line downwind by a factor equal to the square root of 2 where the source of pollution is a row of chimneys in a line set across wind. If allowance is made for lateral diffusion across wind the result which is applicable to a single chimney is rather simpler—doubling the wind speed or doubling the rate of diffusion, halves the axial concentration of smoke downwind from a single chimney.

There is inadequate experimental knowledge regarding the pollution from a continuous source of smoke covering a large area such as a town. It is important to know first of all the concentration of smoke due to chimneys several miles away even as much as an hour after the smoke has been emitted.

It is also necessary to consider whether smoke is removed from surface air either to the ground or to a region in the upper air from which it has a very much reduced chance of diffusing back to the surface. If the rate of removal up or down is large enough to be a controlling factor in determining the concentration of smoke in the surface air, one of two things may be expected to happen:

1 If removal up or down is a function of the distance traveled by smoke, then it should be expected that wind speed is important in determining the concentration of smoke in cities.

2 If removal up or down is a function of time only, then in a sufficiently large city wind speed will be unimportant and turbulence will be the dominating factor.

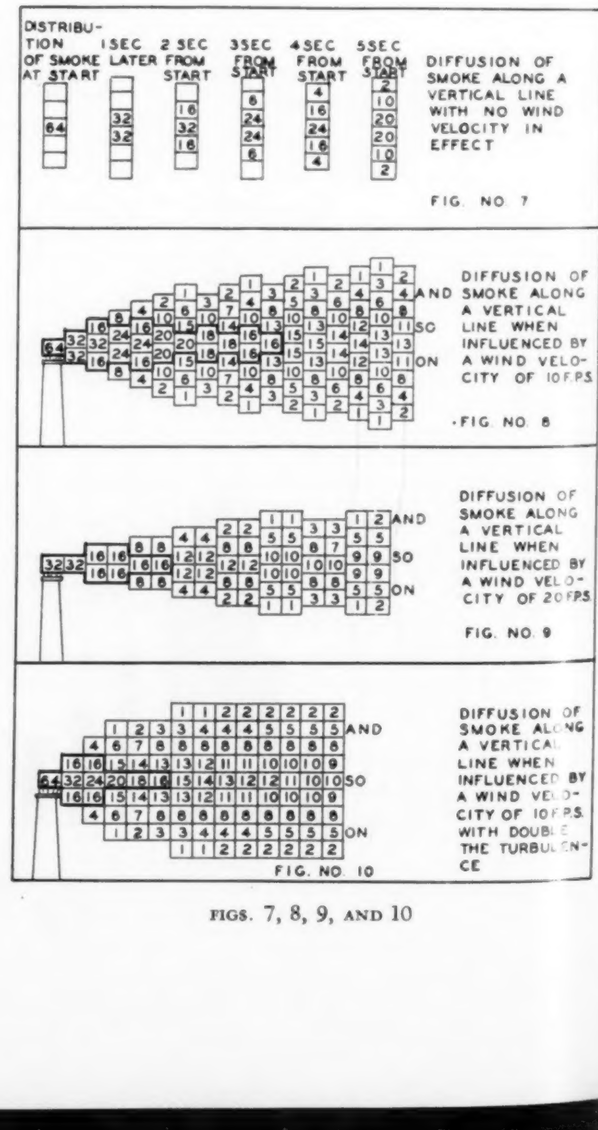
Both wind velocity and turbulence are extremely difficult to measure and little investigation has been carried out. However, based on a little knowledge that was gained during the Leicester, England, survey regarding the effect of turbulence, gaged by the lapse rate, the measurements of daily average concentration of smoke were found to be consistent with the following conclusions:

1 In any given wind speed, the concentration of smoke in central Leicester decreased linearly with the lapse rate.

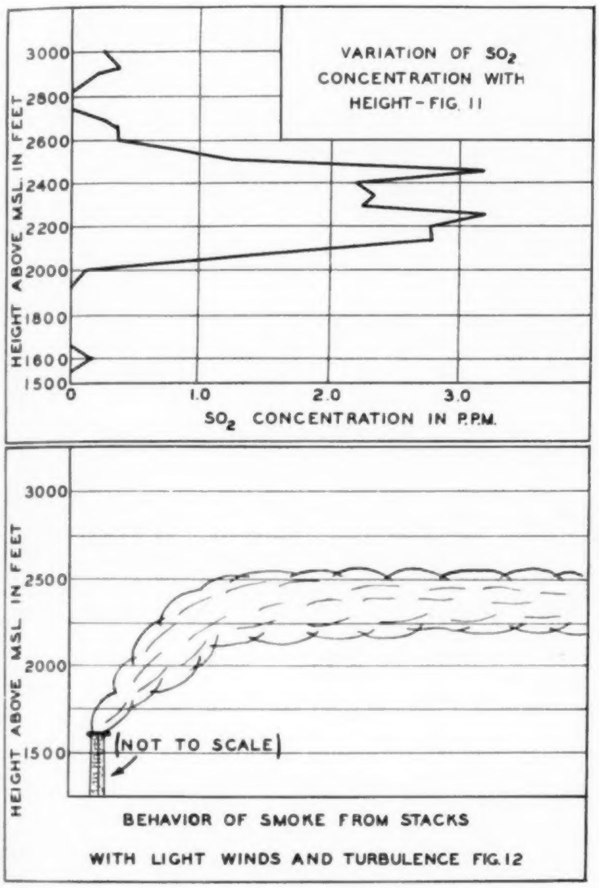
2 In any given lapse rate the concentration of smoke in central Leicester varied at a rate proportional to the inverse square root of the wind speed.

In regard to the second conclusion, in any given lapse rate the turbulence increases with increasing wind speed, particularly in cities when the obstruction of the wind by high buildings produces large eddies.

This conclusion tends to indicate that in a given degree of turbulence, the concentration of smoke may be almost independent of wind speed.



FIGS. 7, 8, 9, AND 10



FIGS. 11 AND 12

This condition in turn suggests that the rate of upward and downward removal of smoke from the surface air is important in a city. In addition, the rate of removal up or down depends on time rather than the distance traveled by the air. There is an urgent need for more experimental work to be carried out on this phase of the problem; but based on the rather meager evidence that is available, the concentration of smoke in a city is much more strongly affected by turbulence than by wind speed.

The importance of the influence of turbulence on atmospheric pollution was fully realized by Dr. A. W. Hewson (4) and his associates during their study as an International Commission of the causes and remedy of the destructive effects of the flue gases discharged from the chimney of the smelter at Trail, British Columbia, Canada. This plant is situated in the deep valley of the Columbia River about seven miles from the boundary between the United States of America and Canada.

At times, under certain weather conditions, the destructive fumes of sulphur dioxide sweep down the valley to destroy crops and vegetation.

When inversions or isothermal conditions are experienced, the gases are effectively held within the steep confines of the valley and thus flow downstream, in what may be considered as a huge conduit. Samples of the atmosphere were taken at various heights above mean sea level and the sulphur-dioxide concentrations in parts per million were ascertained. The results of one series of determinations are shown in Fig. 11 where the samples were taken during the night of May 17, 1940, from 1:35 a.m. to 1:50 a.m. As Dr. Hewson (4) points out, the horizontal stratification of the gas is quite marked. Such a condition was to be expected in the early morning when isothermal and inversion conditions existed.

Based on a mathematical statistical analysis of numerous smoke observations Hewson and his associates found that the smoke during the early morning followed a pattern similar to that sketched in Fig. 12. The stacks are approximately 400 ft in height, with the chimneys discharging at 2000 ft. The gases on discharge are about 100 F warmer than the surrounding air and with light wind the gases mix and drop in temperature at a greater lapse rate than either the dry or moist adiabatic lapse rates.

Upon reaching 2500 ft the gases reach equilibrium with the surrounding air and afterward flow downstream as a ribbon about 200 ft in thickness and at nearly constant height.

As Hewson (4) has pointed out in the report of the investigations carried out at Trail, B. C., the heating of the sides of the valley is the factor that causes a cross movement of air in the valley from one side to the other. As the sun is rising, the westerly bank of a river running approximately north and south (for instance, the Monongahela) is heated more than the easterly side. As a result, convection currents lift parcels of air upward along the westerly bank and there is a downward air movement on the cool shaded eastern side. As the sun moves through the heavens, there comes a period during hours flanking noon when the action is more or less uniform throughout the valley, while in the late afternoon the easterly bank is warmed and the air movements are upward on that side. Because of the greater heights and the more rugged terrain of the Columbia River valley these air currents are in all probability more pronounced than those experienced in the Monongahela River valley; but this potential influence is present in most valleys.

From the foregoing statements it will be realized that there can exist a daily cycle of air conditions over a highly industrialized area, in which topography, location, and seasons combine to create polluted atmospheric conditions provided general large-scale weather phenomena favor it.

CONCLUSION

No suggestions or methods are advanced as a palliative or cure for pollution that becomes concentrated in the atmosphere when stable air conditions as described are experienced. The problem is one that requires deep study, and if this paper has in some small degree drawn thoughtful attention to a few of the factors that play such an important part in the problem of atmospheric pollution, it will have succeeded in its purpose.

Grateful acknowledgment is given to Dr. A. R. Meetham of the Department of Scientific and Industrial Research in London for his helpful data, to Dr. A. W. Hewson of the Canadian Meteorological Service for his permission to use some of the data collected during the Trail air-pollution investigation, and to the U. S. Government forecasters at Allegheny Air Port Weather Station for their co-operation in furnishing the lapse rates experienced in the Pittsburgh industrial area on certain days.

Lastly, credit is due to Jack MacLachlan of the author's staff for his patient preparation of the diagrams.

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HYDROGEN ATTACK *on* CARBON STEELS

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THE deleterious effects of hydrogen on carbon steel have been recognized for many years. Steel that is exposed to a hydrogen medium is susceptible to embrittlement. In some cases this embrittlement may be removed by tempering, but in other cases it is of a permanent nature. Many investigations have been conducted to determine the critical factors which affect hydrogen attack. Publications reporting these investigations, which have been reviewed, are listed in the Bibliography.[2] As a supplement to these researches, the present paper summarizes investigations of hydrogen attack which were conducted on plant equipment at the Charleston, West Virginia, plant of the author's company. The information may be useful in the design of equipment for processing hydrogen.

HANDLING GASES AT HIGH PRESSURES AND HIGH TEMPERATURES

Considerable experience has been attained in handling, at elevated temperatures and pressures, a gas containing approximately 95 per cent hydrogen, 3 per cent nitrogen, and 2 per cent methane. One process is carried out with this gas in a system consisting essentially of converters, heat exchangers, and interconnecting fusion-welded piping. The pressure throughout the closed system averages 350 psi. Temperatures of 310 to 340 C are attained in the piping from the heat exchangers to the converters. The gas returning to the heat exchangers from the converters varies between 355 and 370 C.

Seamless tubing, lap-welded pipe, and butt-welded pipe made of low- to medium-carbon straight-carbon steels have been used as piping materials. In addition, Toncan iron butt-welded pipe has recently been used to replace portions of the steel pipe. The heat exchangers are made of low-carbon steel plate, while the converter shells are of the same material but are lined with AISI type-430 stainless steel, a material which resists hydrogen attack under the conditions of temperature and pressure encountered in this service.

The possibility of hydrogen embrittlement of the carbon-steel elements, operating in the pressure and temperature range employed, prompted frequent inspections of the equipment. Twenty-nine investigations of various components have been made since the system was placed in operation. Twelve of these investigations disclosed recognizable damage from hydrogen attack. The length of time that these sections had been exposed before examination varied from 6 months to 6 years. In no case was hydrogen attack found in a component which had been exposed for less than 2 years. However, when found after 2 years of exposure, the attack was in an advanced stage and probably started well before the sampling time. Other sections which had been in contact with hydrogen at equal temperatures and pressures for as long as 4 years showed no signs of attack.

TABLE 1 SUMMARY OF INVESTIGATIONS OF HYDROGEN ATTACK ON CARBON STEEL AT 350 PSI

Average operating temperature, deg C	Length of service	Material	Results of examination
370	4 years	0.20% carbon steel pipe	Severe attack
370	4 years	0.14% carbon steel pipe	Severe attack
365	4 years	Low-carbon steel pipe	No attack
365	2 years	SAE 1035 steel pipe	Severe attack
365	2 years	Low-carbon steel pipe	Indications of attack
365	2 years	0.13% carbon steel pipe, butt-welded	Superficial attack
365	20 months	Low-carbon steel pipe	No attack
365	16 months	SAE 1035 steel pipe	No attack
360	31 months	0.20% carbon steel pipe, seamless	No attack
360	31 months	0.20% carbon steel pipe, seamless	No attack
360	31 months	0.20% carbon steel pipe, seamless	No attack
360	31 months	0.08% carbon steel pipe, lap-welded	No attack
360	31 months	0.08% carbon steel pipe, lap-welded	No attack
360	31 months	0.08% carbon steel pipe, lap-welded	No attack
360	2 years	0.10% carbon steel pipe, lap-welded	Superficial attack
360	20 months	0.06% carbon Toncan iron	No attack
360	6 months	0.06% carbon Toncan iron	No attack
355	6 years	0.20% carbon steel plate	Heavy attack
355	6 years	0.20% carbon steel plate	Heavy attack
355	31 months	0.20% carbon steel pipe, seamless	No attack
355	31 months	0.08% carbon steel pipe, lap-welded	No attack
355	2 years	0.19% carbon steel pipe, seamless	No attack
355	2 years	0.20% carbon steel plate	Heavy attack
355	2 years	Low-carbon steel tubing	Indications of attack
320	2 years	Low-carbon steel pipe	No attack
310	4 years	0.10% carbon steel pipe	Heavy attack
310	2 years	Low-carbon steel pipe	Slight attack
310	20 months	Low-carbon steel pipe	No attack
225	2 years	0.20% carbon steel pipe	No attack

All sections that showed attack were made of straight-carbon steels containing from 0.10 to 0.35 per cent carbon. A section of Toncan iron, a low-carbon iron containing small amounts of molybdenum and copper, showed no signs of attack when examined after 20 months of exposure. However, a longer exposure may lead to the initiation of such attack.

RESULTS OF INVESTIGATIONS ON HYDROGEN ATTACK

Table 1 lists all investigations made on this system to determine the presence of hydrogen attack. It indicates the operating temperature of the individual component examined, the length of time it was exposed to hydrogen at that elevated temperature, a brief description of the material from which the component was made, and whether or not attack was found.

[1] E. I. du Pont de Nemours and Company, Inc., Sabine River Works, Orange, Texas.

[2] The Bibliography appears at the end of the paper.

Contributed by the Joint Research Committee on Boiler Feedwater Studies of The American Society of Mechanical Engineers.

FIG. 1 EXTERNAL VIEW OF HEAT-EXCHANGER HOT HEAD AFTER 6 YEARS OF EXPOSURE TO HIGH TEMPERATURE AND PRESSURE HYDROGEN; 1/7 ACTUAL SIZE

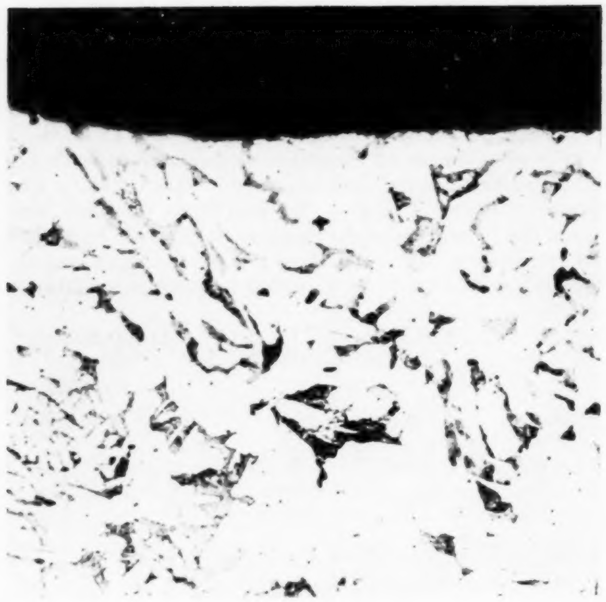

FIG. 2 INNER EDGE OF SECTION A, FIG. 1, SHOWING LACK OF HYDROGEN ATTACK AS EVIDENCED BY PRESENCE OF PEARLITE AT SURFACE AND FREEDOM FROM FISSURING
(4 per cent picral etch, 60 sec; ×150.)

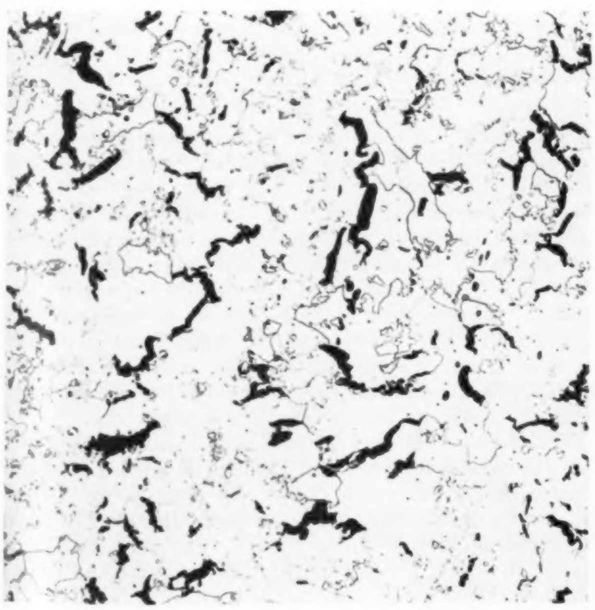

FIG. 3 AREA 0.06 IN. FROM INNER EDGE OF SECTION B, FIG. 1, SHOWING HYDROGEN ATTACK, AS EVIDENCED BY FISSURING ALONG GRAIN BOUNDARIES AND DEPLETION OF PEARLITE
(5 per cent nital etch, 15 sec; ×150.)

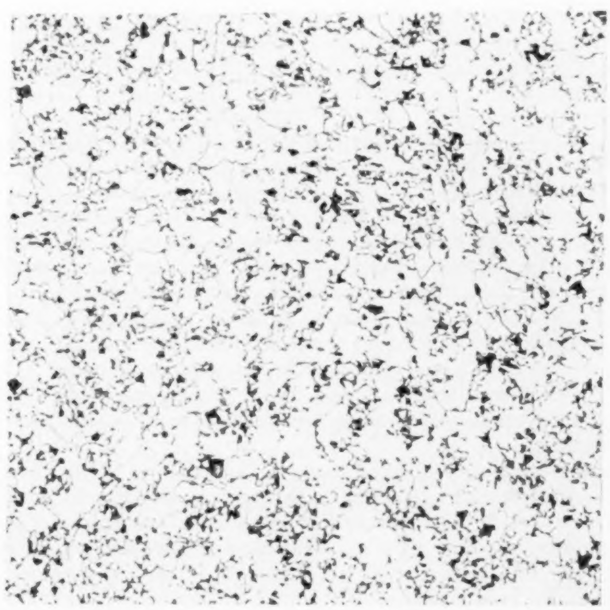

FIG. 4 AREA NEAR OUTER EDGE OF SECTION B, FIG. 1, SHOWING FREEDOM FROM ATTACK, AS EVIDENCED BY PRESENCE OF UNDISTURBED PEARLITE AND LACK OF FISSURING
(5 per cent nital etch, 15 sec; ×150.)

Three tests were used to detect hydrogen attack, namely, a 180-deg reverse-bend test to detect loss of ductility, macroetching in hot 1:1 hydrochloric acid to display fissuring, and microscopic examination to show decarburization and fissuring.

Several factors must be considered when interpreting the results of the various investigations. This equipment has been in continuous operation and therefore sampling had to be done at times and locations that were convenient to the operating schedule. Because of these limitations the frequency and continuity of observation which is characteristic of a well-planned research investigation were not possible. Therefore some factors or observations which are desirable for precise correlation of results are missing. In addition, this system is apparently operating in the critical region of temperature and pres-

sure where hydrogen attack may or may not occur. Consequently, small changes in steel composition, grain size, manufacturing processes or conditions, localized stresses, or other variables inherent in the steel may result in a marked change of susceptibility to hydrogen attack. However, it is believed that for practical design purposes the observations are of value.

One such example of nonuniform occurrence of hydrogen attack was found in the examination of the hot head of a heat exchanger, shown in Fig. 1. Four different materials were used in the fabrication of this head, as indicated in the figure. The composition, as determined by chemical analysis, and the estimated grain size of each section are shown in Table 2.

TABLE 2 ANALYSIS AND GRAIN SIZE OF HEAT-EXCHANGER-HEAD COMPONENTS

Section	C (Per cent)	Mn (Per cent)	Si (Per cent)	Timken, ASTM grain size no.
A	0.17	0.48	0.17	6
B	0.20	0.46	0.03	7
C	0.21	0.30	0.01	2
D	0.19	0.48	0.22	6

This head had been in use for 6 years where it was exposed to 95 per cent hydrogen gas at a pressure of 350 psi and a temperature of 355 C. Examination after this service revealed that sections *A*, *C*, and *D* were free of attack, as shown by bend tests and microscopic examination.

Fig. 2 is a photomicrograph of the inner edge of section *A*. It shows undisturbed pearlite extending to the surface and lack of fissuring at the grain boundaries. Section *B*, however, was excessively decarburized and fissured, as shown in Fig. 3, through approximately three quarters of the wall thickness. Fig. 4 is a photomicrograph of an area near the outside edge of section *B* displaying no attack. Samples of complete cross sections from this section fractured after 20 to 30 deg of reverse bending.

CONCLUSIONS

From these investigations it was concluded that straight low-carbon steels containing from 0.10 to 0.35 per cent carbon are susceptible to hydrogen attack at pressures of 350 psi and temperatures above approximately 300 C. Until more definite information is available, the use of mild steel in services similar to this should be discouraged, since the time or location at which attack will occur and progress far enough to cause a failure cannot be predicted accurately.

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5 "Boiler Embrittlement," by C. A. Zapffe, Trans. ASME, vol. 66, 1944, pp. 81–117.

The Engineer and World Recovery

IT IS only in the last few years that the profession as such has seen the folly of political isolationism. The engineering profession today, as represented by Engineers Joint Council, has successfully demanded of our nation's lawmakers that engineers be declared "in" on the discussion of many national questions. The State Department, the War Department, the Department of the Interior and other federal bureas have learned that an engineering profession actually exists and, on occasion, has something worth while to contribute. In the main, we have been welcome in the Washington councils.

In Engineers Joint Council, the profession has become effectively articulate on many legislative matters which affect engineers.

Representatives of Congressional Committees, of the War Department and of the State Department at different times have asked to be permitted to explain to EJC some matter of engineering public interest. They do not come seeking some purely political advantage. The votes of all the EJC societies' members, even if they all voted one way, are but a drop in the national political vote bucket. These men from Washington come to EJC for help and advice in solving some problem of their own in which engineers or engineering has a part.

We are pardonably proud that this is so, and we are doing everything we can to increase the legislative demand for advice from the engineering profession during the period that legislation is in the making. The difficulty of obtaining desirable changes in a bill is increased tenfold, once it has been printed and introduced in either House. Engineers Joint Council has had the courage and the energy to get into the game where it can benefit the profession and the public.

What has this relatively newborn interest of engineers in matters other than engineering to do with peace for the world?

The causes of war and of peace lie in the living standards of people. Basically, the European Recovery Program is aimed at enhancing the standard of living in a large segment of the world which never has enjoyed the blessings we in the United States take for granted. Since the engineering profession played so great a part in bringing about our high American standard of living, it is logical that it should be called upon now to contribute to the well-being of the peoples we are endeavoring to assist through ERP. Moreover, the engineer can give major assistance in the enormous job called for under the ERP with the full public confidence and respect which American technological superiority has won throughout the world.

Even during this uneasy peace which has followed V-J Day, the engineering profession has been mobilizing for active participation in our nation's efforts for peace, whether those efforts are to be through giving a higher standard of living to the world, or toward ultimate peace only by fighting for it again. In short, we are being realistic about the future. While we hope, like all Americans hope, that peace may be attained without another war, we are not unmindful of the unstable and frightening world conditions today. In close co-operation with the War and other federal departments, we have taken recent steps toward assuring the fullest possible use of America's engineers should war come again. We know from surveys made that neither in military nor civilian wartime service in World War II was the best utilization made of technological personnel, either in military operations or in industry. We are determined that such wanton wastage of scarce skills shall not occur again if war comes. (From an address by Col. W. N. Carey, executive secretary, American Society of Civil Engineers, before the Chamber of Commerce of Pittsburgh, Pa., April 8, 1948.)

PUMPING REQUIREMENTS *for* IRRIGATION

On Columbia Basin and Central Valley Projects of the Bureau of Reclamation

By IRVING L. WIGHTMAN

BUREAU OF RECLAMATION, DENVER, COLO.

COLUMBIA BASIN PROJECT

THE Columbia Basin Project lies within the bend of the Columbia River in south-central Washington and covers an area of 1600 square miles.

In 1903 the then newly organized Reclamation Service made its first survey of the Columbia Basin Project. This survey, which showed great possibilities for large-scale development, was followed by investigations under a co-operative agreement between the State of Washington and the Reclamation Service in 1914 and 1915 and by the Columbia Basin Survey Commission in 1919 and 1920. In 1921 General George W. Goethals made a favorable report on the construction of the project to the State of Washington. In 1924 the late Dr. Elwood Mead, then Commissioner of Reclamation, recommended to the Secretary of the Interior that further studies be made before undertaking the gigantic scheme of development. During these years a controversy arose over whether the development should be made by constructing a dam over the Columbia River and pumping water into the basin, or whether the water should be diverted from an upstream tributary and carried to the irrigable lands across the state by a system of gravity canals. Eventually the pumping plan was adopted.

From 1927 to 1931, the Army Engineers made a thorough investigation and, in 1932, presented to Congress a comprehensive report which indicated many advantages of the pumping plan over the gravity-flow scheme. The results of this investigation did much to bring about the present project plan.

In 1933 the late President Roosevelt authorized the Bureau of Reclamation to proceed with the construction of the Grand Coulee Dam and made available from emergency funds a total of $63,000,000. The plan at that time called for construction of a low dam for power development and provided for raising the height to 550 ft at a later date for irrigation development.

About that time, due to the prolonged drought, thousands deserted their homes and farms in the dust bowl of the Missouri River Basin and made their way to the Pacific Coast. The migration to the Pacific Northwest made the development of irrigated land in the Columbia Basin of prime urgency. For this reason, and the fact that the greater storage and better regulation afforded by the high dam made large-scale power development on the Columbia River and its tributaries more feasible, an order was issued by the Secretary of the Interior in 1935 calling for the construction of the Grand Coulee Dam to its full height of 550 ft.

The main purpose of the project is to provide irrigation water for over 1,000,000 acres of highly fertile land extending from Coulee City south to Pasco, Wash. The final plan for the development of the project comprises facilities for storage and regulation of Columbia River water, for the distribution of irrigation water to lands in the basin, and for the generation of power. Storage of Columbia River water for irrigation supply and power is accomplished by the Grand Coulee Dam, completed in 1942, which also regulates the flow of the river to improve navigation and power generation downstream. At the downstream toe of the dam, on either side of the river are the power plants, which will have an ultimate capacity of 1,944,000 kw for pumping irrigation water and providing a firm commercial supply. The Grand Coulee Pumping Plant, located just upstream from the dam structure on the west abutment, will lift water from the 9,517,000-acre-ft Lake Roosevelt, which is formed behind the dam to a canal leading to a 615,000-acre-ft balancing reservoir to be formed by constructing dams at the ends of the Grand Coulee. From the balancing reservoir, water will flow into a vast system of canals, siphons, tunnels, and laterals to the farm lands. Relift pumping plants will be constructed at various points along the canals to raise the water to higher lands.

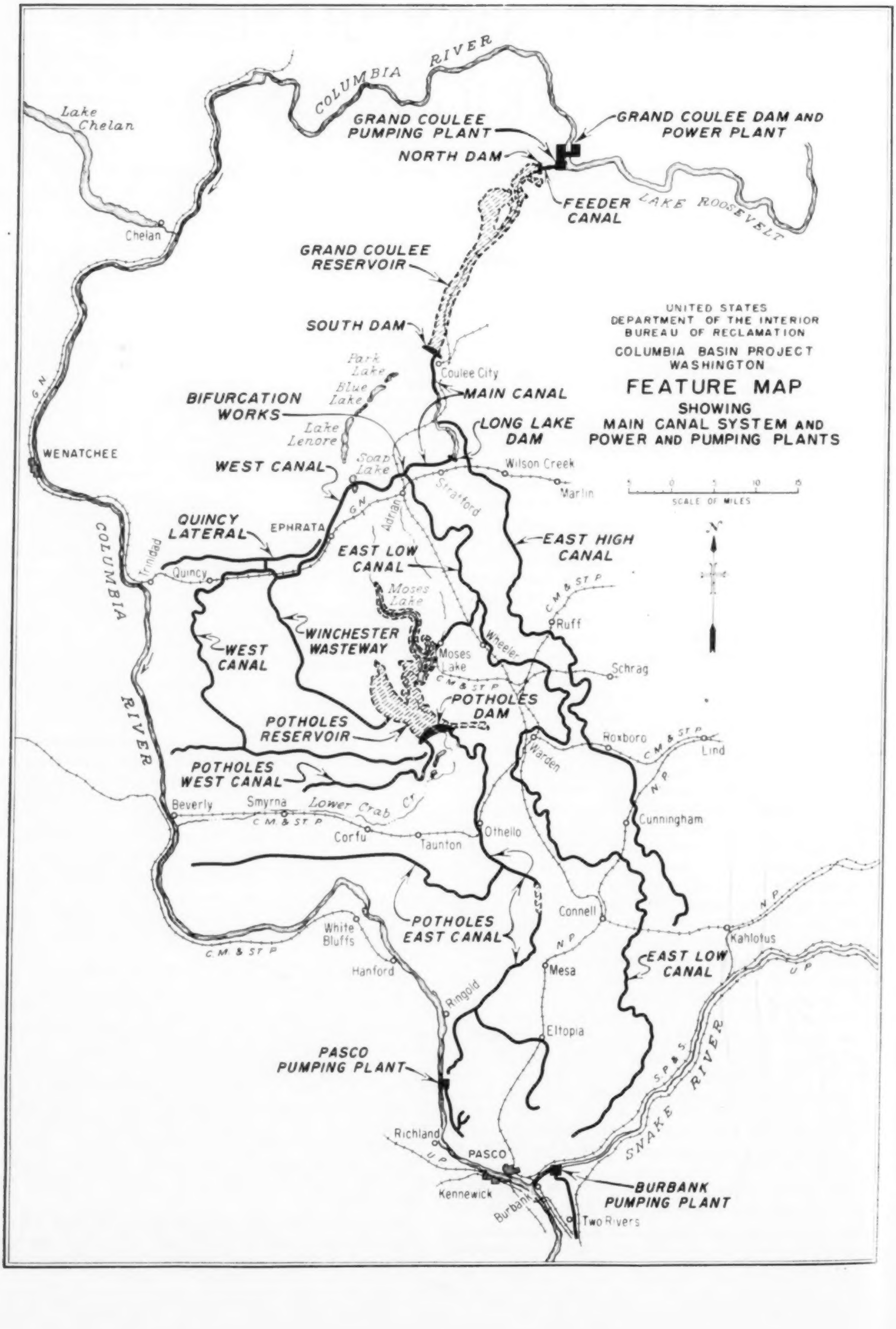
Studies have been made of the water requirements for the various types of soils found in the project area, taking into consideration the crops to be grown and the water-holding capacity of the soil. The average annual water requirement is estimated at 3.7 acre-ft per acre. About 23 per cent of the annual demand may be required in 1 month, and the canal system is being designed to meet this requirement.

The Columbia River, draining an area of 74,000 sq miles upstream from the dam, has an average annual run-off of 77,500,000 acre-ft, and it is estimated that the annual irrigation demand upon full development of the project will be 4,000,000 acre-ft.

The pumping units that will be installed in the Grand Coulee Pumping Plant will be required to raise this large quantity of water a distance of several hundred feet. Initially six motor-driven pumping units will be installed in the plant which is designed for an ultimate installation of 12 units. The pumps are now being manufactured under contract and are scheduled for operation July 1, 1949. Each pump will have a capacity of approximately 1600 cfs at the low lift of 270 ft, when the surface of the lake is at high level, and will be driven by a 65,000-hp direct-connected synchronous motor. Two pump motors will be supplied with power from one 108,000-kva hydraulic-turbine-driven generator unit in the Grand Coulee Power Plant.

The level of the water in Lake Roosevelt from which the irrigation water will be drawn will fluctuate as much as 95 ft and, as a result, the total pumping head will vary from 270

Contributed by the Hydraulic Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of The American Society of Mechanical Engineers.


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLUMBIA BASIN PROJECT
WASHINGTON
FEATURE MAP
SHOWING
MAIN CANAL SYSTEM AND
POWER AND PUMPING PLANTS
SCALE OF MILES
COLUMBIA RIVER
Lake Chelan
GRAND COULEE PUMPING PLANT
GRAND COULEE DAM AND POWER PLANT
NORTH DAM
FEEDER CANAL
LAKE ROOSEVELT
Chelan
GRAND COULEE RESERVOIR
SOUTH DAM
Coulee City
Park Lake
Blue Lake
Lake Lenore
Soap Lake
MAIN CANAL
BIFURCATION WORKS
LONG LAKE DAM
WENATCHEE
Wilson Creek
Marlin
WEST CANAL
Stratford
Adrian
QUINCY LATERAL
EPHRATA
EAST HIGH CANAL
EAST LOW CANAL
Trinidad
Quincy
Moses Lake
Ruff
WINCHESTER WASTEWAY
WEST CANAL
Moses Lake
Wheeler
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POTHOLES DAM
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Smyrna
Lower Crab Cr.
Cunningham
Corfu
Taunton
Othello
POTHOLES EAST CANAL
Connell
White Bluffs
Hanford
Kahlotus
EAST LOW CANAL
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Kennewick
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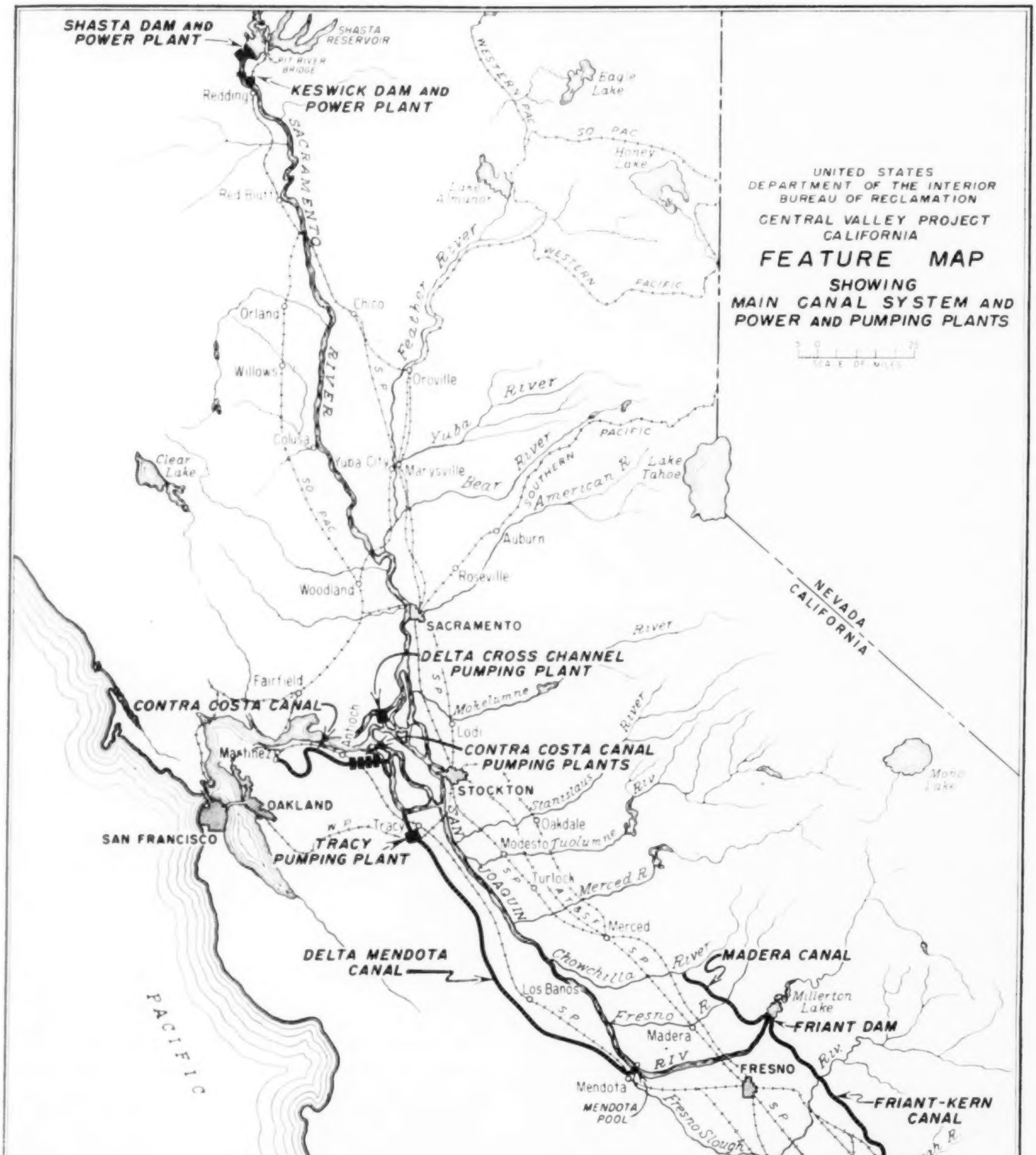
BURBANK PUMPING PLANT
Two Rivers


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT
CALIFORNIA
FEATURE MAP
SHOWING
MAIN CANAL SYSTEM AND
POWER AND PUMPING PLANTS
SHASTA DAM AND POWER PLANT
SHASTA RESERVOIR
KESWICK DAM AND POWER PLANT
Redding
SACRAMENTO RIVER
Red Bluff
Chico
Orland
Willows
Oroville
Feather River
Yuba River
Bear River
American R.
Colusa
Yuba City
Marysville
Clear Lake
Lake Tahoe
Auburn
Roseville
Woodland
SACRAMENTO
DELTA CROSS CHANNEL PUMPING PLANT
Fairfield
CONTRA COSTA CANAL
Antioch
Mokelumne
Lodi
CONTRA COSTA CANAL PUMPING PLANTS
Martinez
STOCKTON
OAKLAND
SAN FRANCISCO
Tracy
TRACY PUMPING PLANT
Oakdale
Modesto
Tuolumne
Turlock
Merced R.
Merced
SAN JOAQUIN
NEVADA
CALIFORNIA
Mono Lake
DELTA MENDOTA CANAL
Chowchilla River
MADERA CANAL
Millerton Lake
FRIANT DAM
Los Banos
Fresno R.
Madera
FRESNO
Mendota
MENDOTA POOL
Fresno Slough
FRIANT-KERN CANAL
Kings
Hanford
Visalia
Kaweah R.
Tulare
Tule Riv.
Tulare Lake Basin
Delano
Kern Riv.
BAKERSFIELD
Buena Vista Lake
PACIFIC OCEAN
Eagle Lake
Honey Lake
Lake Almanor

ft to 365 ft. The high head will occur only at infrequent intervals of short duration. For about 70 per cent of the time, the low-head condition will prevail. The weighted average head on the pumps is expected to be about 290 ft.

In pumps of such unprecedented size, the over-all efficiency and smooth performance of the units are of such importance that every feature of the plant, from the intake to the headworks of the canal leading to the balancing reservoir, was investigated to determine the hydraulic conditions. Hydraulic model tests were made in the laboratory of the Bureau of Reclamation on all the features except the pumps, and an extensive research program was carried out in the hydraulic laboratory of the California Institute of Technology on pump models to develop and verify the pump design, including the design of the inlet elbow, and to determine the hydraulic performance, the limitation of specific speed as affecting cavitation, and the characteristics over the entire range of pumping heads.

In order to provide irrigation water to 6000 acres of farm land considerably in advance of the completion of the reservoir and gravity canal system which will eventually serve this area, the Pasco Pumping Plant is being constructed. This plant, which is situated on the Columbia River at a point 14 miles northwest of Pasco, Wash., will lift the water 167 ft directly from the river by means of two vertical electric-motor-driven centrifugal pumps, each with a capacity of 63 cfs. First delivery of water from the Pasco plant is planned for the 1948 season.

CENTRAL VALLEY PROJECT

The Central Valley Project is 450 miles long and approximately 50 miles wide and lies west of the Sierra Nevada and east of the Coast Range between Mount Shasta on the north and the Tehachapi Mountains on the south. The Sacramento River flows through the valley from the north, and the San Joaquin River from the south.

For almost 70 years, studies leading to the development of the water resources of California have been made by the Federal and State Governments. In 1874 a three-man commission of the War Department, appointed the previous year by Congress, recommended the first valley-wide plan for co-ordinated water development. In 1878 the first State Engineer of California initiated investigations to provide a system of irrigation, promote rapid drainage, and improve navigation on the Sacramento and San Joaquin Rivers. In 1920 the State of California began detailed studies of water resources and, by 1930, a long-range plan of ultimate water development was formulated. A joint Federal-State Water Resources Commission made a report to the President of the United States and to the Governor of California in late 1930, recommending construction of the Central Valley Project.

The Central Valley Act of 1933 of the State of California authorized the construction of a Central Valley Project similar to the one now under construction and provided that revenue bonds not exceeding $170,000,000 could be issued for financing the project. It was then the middle of the depression, and the State did not raise the necessary funds. In 1935 the Secretary of the Interior made recommendations to the President for its construction under a Federal Reclamation Project. It was immediately approved, and the project was authorized by Congress under the Rivers and Harbors Act in 1937.

Practically all of the rainfall throughout the valley occurs during the winter, and irrigation is required for all summer crops. The rainfall in the Sacramento River Basin is about twice that in the San Joaquin Valley where the demand for irrigation water is greatest. Since the streams become practically dry after midsummer, the farmers found it necessary to irrigate from wells. As a result of this pumping, the underground reservoirs in the San Joaquin Valley are being rapidly depleted and thousands of acres are going out of production.

While this serious overdraft of water supplies was developing in the San Joaquin Valley, the water shortage was resulting in a different kind of damage near the junction of the Sacramento and San Joaquin Rivers. This area, known as the Delta, comprises about 400,000 acres of good land lying so near sea level that the tides rise and fall in the numerous channels which meander through the area. In late summer, the inflow to the delta is reduced to such an extent that there is not sufficient fresh water to meet the needs of the irrigated lands or to repel the intrusion of ocean water. As a result, salt water moves in from the ocean, increasing salinity in the delta channels to such a point that it is unfit for irrigation.

The project, which is now under construction, consists of the following: Shasta Dam and Reservoir having a capacity of 4,389,000 acre-ft for storage and regulation of the Sacramento River water; Shasta Power Plant for generation of 375,000 kw of power for pumping and commercial use; Keswick Dam Reservoir with a capacity of 23,700 acre-ft for reregulating the releases from Shasta Power Plant and providing an installed power capacity of 75,000 kw for producing peaking power; Delta Cross-Channel Pumping Plant for transferring water from the Sacramento River across the delta to prevent the encroachment of salt water and to supply water to the Contra Costa and Delta-Mendota Canals; Friant Dam and Reservoir for storage and regulation of San Joaquin River water; Friant-Kern Canal from Friant Dam to Bakersfield for supplying irrigation water; and Madera Canal to transmit water from the San Joaquin River for use in Madera County. The Shasta and Keswick Power Plants and Dams are scheduled for completion in 1948. The Contra Costa Canal, which has been in operation for several years, supplies fresh water to heavy industries and for irrigating farms in the area between Stockton and Martinez.

The terrain over which the Delta Mendota Canal is being constructed requires that the water be raised about 200 ft at the Tracy Pumping Plant.

Studies were made to determine which one of three schemes considered was the most economical: Four pumping plants in series, each to lift the water 50 ft; two plants in series, each for a 100-ft lift; or one plant for a 200-ft lift. These studies indicated that a considerable saving would be realized by constructing a single plant.

The Tracy Pumping Plant is being constructed on the Delta Mendota Canal near Tracy, Calif., to raise 4600 cfs; the capacity of the canal, in one lift of approximately 200 ft. Six vertical-shaft motor-driven centrifugal pumps, each with a capacity of 767 cfs when operating under a total pumping head of 197 ft, will be installed in this plant. Each pump will be driven by a 22,500-hp direct-connected synchronous motor.

The Delta Cross-Channel Pumping Plant, which will transfer about 10,000 cfs of water from the Sacramento River to the Delta, will probably contain six vertical-shaft motor-driven propeller pumps. Each pump will have a capacity of about 1650 cfs when operating under a maximum pumping head of 7 ft and will be direct-connected to a 1500-hp motor. Due to the fluctuation of the water surfaces in the river, the pumping heads will vary from a maximum positive head of 7 ft to a minimum negative head of 10 ft, and consideration will be given both to an adjustable-blade propeller-type pump driven by a constant-speed motor, and a fixed-blade propeller-type pump driven by a variable-speed motor.

There are four pumping plants now operating in series on the Contra Costa Canal to raise the water in the canal in lifts of 26.5, 25, 33.5, and 50.5 ft, respectively. Each of the plants is designed for an ultimate installation of six units with a combined capacity of 350 cfs.

FUTURE FUELS—
LIQUID *and* GASEOUS

By BRUCE K. BROWN and R. C. GUNNESS

STANDARD OIL COMPANY (INDIANA), CHICAGO, ILL.

A DISCUSSION of the future of liquid and gaseous fuels can be broken down logically enough into three interlocking basic questions: "What kinds of fuel," "how much," and "when?" For an understanding of the subject, something of the terminology of the petroleum industry must be explained. Oil men think in terms of barrels—usually barrels per day—and producers of gas in millions of cubic feet.

So let us visualize what a barrel of liquid petroleum means. Primarily it means 42 U. S. gal of oil, and the contents of 7 such barrels would weigh about a ton. We say "would weigh," because oil is not actually handled in barrels of this size. Today the 42-gal barrel is only a basis for calculation, handed down to us from the days when wooden-staved barrels of this size were actually used to hold and transport petroleum. We still stick to it as a mathematical unit of measurement; but for practical purposes we use a steel drum instead, usually of 55 gal capacity.

For further orientation, let us consider the fuel value of 1 ton of oil (that is, 7 bbl), as related to 1 ton of coal. The ratio will differ, of course, with varying fuel qualities, but, roughly speaking, 1 ton of average oil has in it about one third more British thermal units than 1 ton of average coal. The useful heat obtainable by burning these fuels varies tremendously with the kind of petroleum product or coal and the conditions of combustion, but it is fair to state that the liquid nature of petroleum has thus far given it a large and consistent advantage over coal in actual efficiency of combustion.

Natural gas too varies somewhat in Btu content, depending upon its composition. Natural gas delivered to the city of Detroit has a calorific value of about 1100 Btu per cu ft. This means that a quantity of such natural gas large enough to contain as many Btu as 1 ton of oil would occupy a total of 35,000 cu ft and require a cubic vessel about 33 ft on an edge to hold it at atmospheric pressure.

NATIONAL PETROLEUM REQUIREMENTS

Now, having established a basis for our thinking about this seven-to-the-ton barrel of oil, let us examine our national requirements for petroleum. During 1947, we used about 5,800,000 bbl of petroleum every day. But how much is that? To convey its magnitude, let us express it in more familiar dimensions. Five million eight hundred thousand barrels is 80 per cent of the volume of water used daily in the City of Detroit. The United States derives about 40 per cent of the energy it uses from this oil and from the natural gas that is produced either separately or in conjunction with liquid petroleum.

So much for groundwork. Now, how about liquid fuels in the future? In order to appraise the future, let us first survey the progress of the past 25 years. Twenty-five years ago worldwide production of crude oil was about 1,900,000 bbl per day; by 1947 it had risen to more than 8,000,000 bbl per day. Current United States production of crude oil is at a rate twice as great as in 1935, and four times as great as in 1921. While 25 years ago the United States proved natural-gas reserves were estimated at 20 trillion cubic feet, they are now estimated at more than eight times this figure, or 170 trillion cubic feet. Refinery crude runs in the United States were about 1,200,000 bbl of crude per day in 1921; in 1947, they were in the neighborhood of 5,300,000 bbl per day. Twenty-five years ago about 27 per cent of each barrel of crude oil was made into gasoline. In 1947, over 40 per cent was so converted, and in modern equipment, we could produce a 75 per cent yield if gasoline were the only product desired. In 1918 we produced 200,000 bbl per day of gasoline; now the figure is more than ten times greater. In summary, it may thus be seen that, over the past quarter century, the petroleum industry has increased its output of all products over fourfold.

Impressive as the increase in production and refining has been, the figures do not at all reveal the magnitude of the technological strides which the industry has taken under the guidance of its scientists and engineers. The rate of progress in product quality and product diversity has been geometric rather than arithmetic. Without these quality advances, the quantitative advance already referred to would have been impossible. Nevertheless, although progress over the past 25 years has been enormous, it has barely enabled the oil industry to keep pace with an apparently ever-increasing demand.

From a broad standpoint, a review of what has happened during the past quarter century and a projection of what will happen during the next similar period are of real value. It is the immediate situation which, undoubtedly, commands greatest interest. It is appropriate to look more closely at what has been happening in the oil business during the last few years.

The United States demand for finished petroleum products in 1947, was 14 bbl for every man, woman, and child. This constituted an increase in consumption of $12^1/_2$ per cent over the preceding year and of 25 per cent over 1941. The total 1947 needs of petroleum products for domestic use, export, and governmental use were 8.3 per cent higher than the peak annual demand during the war. Demand for gasoline was up 7 per cent over 1946 and 20 per cent over 1941, while that for gas oil and distillate fuel oil—that is, products of the type used for home heating and Diesel engines—was up 16 per cent over 1946 and 66 per cent over 1941.

There has been some recrimination that the petroleum industry oversold itself to the American citizen and induced him to install oil heat without knowing where the oil was to come from. While the demand for heating oil, as measured by burner installations, did rise 35 per cent between December, 1941, and September, 1947, the new demand imposed by these burners amounted to less than one fourth of the increased load facing the petroleum industry. Let us consider some other factors, comparing the end of 1947, with prior periods. The number of motor vehicles on the road has increased 7 per cent above the prewar high, with trucks increasing 32 per cent, buses about 29 per cent, and passenger cars 3 per cent. Total gasoline demand

Presented at a Joint Session of the Detroit Section, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, The Engineering Society of Detroit, and the Detroit Section of the American Institute of Chemical Engineers, Detroit, Mich., Jan. 21, 1948.

TABLE 1 TOTAL DEMAND FOR U. S. PETROLEUM PRODUCTS

	—Thousands of barrels per day—		
	1947	1941	Increase
Motor fuel	2290	1910	380
Distillate fuel	880	520	360
Residual fuel	1430	1090	340
Kerosene	300	200	100
All other	950	650	300
Total demand	5850	4370	1480

is up 20 per cent! Large military requirements and peak consumption by industrial users have increased our difficulties. Use of petroleum fuels in farm tractors has doubled in the last 6 years, while the demand for Diesel fuel has risen about 180 per cent in this period. The story is the same in all fields. As an indication of the broad range of higher demands, it is interesting to note that three times as many gasoline-consuming outboard motors were sold last year as in 1941. That the increased demand includes all types of products is illustrated in Table 1.

FUTURE TRENDS

With regard to the future, there is nothing on the horizon to indicate that the utilization of and demand for liquid-petroleum fuels will not continue to increase year by year. Even a serious economic dislocation would probably do no more than retard the trend; it would not turn the demand curve downward. It is to be stressed that what looks like an insatiable demand for liquid-petroleum fuels has not been brought about solely by the increasing mechanization of our civilization. Actually, Americans have come to demand increasing human comfort and transportation luxury, and most of this has been supplied by our liquid and gaseous fuels.

Harry Wiess, president of Humble Oil and Refining Company, put it so succinctly that he should be quoted:

"A major shift from coal to oil, amounting to a revolution in the use of energy resources, has occurred since 1920. The demand for petroleum products in the United States during the past 25 years has increased fourfold! On the other hand, during the last quarter century coal production has equaled the level of 1920 only in two years, 1944 and 1947. Coal's share of U. S. energy production declined from 80 per cent in 1920 to 48 per cent in 1947, while oil and gas production increased so rapidly that their share of U. S. energy production advanced from 16 per cent in 1920 to 48 per cent in 1947. In other words, oil and gas have supplied practically all of the increase in energy production in the past 25 years, and now supply as much energy as coal.

"The shift from coal to oil and gas reflects the success of the petroleum industry in supplying oil. The application of scientific methods enabled the industry to find large new reserves and to provide products at low prices. The relationship between oil and coal prices during this period was such as to make oil more attractive than coal. Cleanliness, convenience, and ease of automatic control for heating were other factors that encouraged the shift to oil. Government controls during World War II tended to accentuate the advantage of using oil rather than coal by keeping the price of oil low while permitting coal prices to rise. Consequently, there was a sharp upward surge in the civilian use of oil immediately following the end of World War II. Home-owners purchased large numbers of oil heaters, railroads ordered Diesel locomotives to replace coal-burning equipment, and other uses of petroleum products also expanded."

Natural-gas consumption has also quadrupled in the past 25 years, as illustrated in Table 2.

In the foregoing, we have established the liquid-fuel requirements of a quarter-century ago and have traced the upward curve to the present. What can we expect in the future? Our

TABLE 2 NATURAL-GAS CONSUMPTION IN UNITED STATES BY USE

	—Billions of cubic feet—				
	Domestic and commercial	Use in oil or gas fields	Carbon black	Other industrial	Total
1920	286	202	41	269	798
1925	272	424	140	352	1188
1930	376	723	267	575	1941
1935	413	580	242	675	1910
1940	579	712	369	996	2656
1944	806	860	370	1731	3767

TABLE 3 ESTIMATED U. S. GASOLINE DEMAND IN 1970

	Thousands of barrels per day
43,000,000 passenger cars	1970
7,100,000 commercial vehicles	720
3,000,000 tractors	130
Aviation gasoline	180
Naphthas	70
Miscellaneous	90
Total	3160

associates, Robert E. Wilson and Joseph K. Roberts,[1] have ventured some estimates of demand by 1970. Based upon United States Public Roads Administration data, a curve was produced in their study showing the probable growth of passenger-car registrations. This curve indicated that the number of passenger cars would increase from the 27,000,000 in 1946, to about 43,000,000 by 1970. After considering the available data, as well as the effect of probable trends in engine design, it was concluded that gasoline consumption per passenger car might be expected to be about 17 bbl per car per year. Gasoline consumption per car is expected to remain high in spite of great improvement in the quality and potential efficiency of gasoline, because it is believed that the customers will elect largely to take advantage of fuel improvements in the form of larger cars, faster acceleration, higher top speeds, and more comfortable driving, rather than in the form of greater mileage per gallon. Truck and other commercial-vehicle registrations were predicted to increase in number at an even faster relative rate than passenger-car registrations, and should rise to more than 7,000,000 by 1970. Gasoline consumption is expected to rise from the 1945 figure of approximately 33 bbl per year per vehicle to about 43 bbl by 1970. On this basis, a summary prediction of all gasoline usage in 1970 is 3,160,000 bbl per day. A breakdown of this estimate is shown in Table 3.

In 1940, only 9.4 per cent of the one and two-family homes in the area where central heating is desirable had oil heat, and, at that time, there were approximately 2,000,000 oil burners in operation. On the basis of past growth of oil heating and the growth patterns and future expectancy of competing fuels, it was estimated last year that the number of domestic oil burners would rise to 4,000,000 by 1950 and to 5,500,000 by 1970. At this level, approximately 22 per cent of the one and two-family homes in the colder areas would be heated by oil. On this basis, domestic fuel-oil consumption would be approximately 250,000,000 bbl by 1970. Oil-burner installations have been proceeding even more rapidly than predicted nearly a year ago.

It is believed that Diesel fuels will also be used much more widely by railroads and other users during the next quarter-century. In spite of the greater original cost of Diesel locomotives, railroads are buying them in increasing numbers because of their manifest advantages as compared with steam locomotives, namely, lower operating costs, reduced maintenance, faster acceleration, smoother operation, elimination of track

[1] "Petroleum and Natural Gas; Uses and Possible Replacements," by Robert E. Wilson and J. K. Roberts, AIME, volume commemorating 75th Anniversary Celebration, New York, N. Y., March 17–19, 1947.

TABLE 4 ESTIMATED DOMESTIC DEMAND FOR PETROLEUM PRODUCTS IN 1970

	Thousand of barrels per day		
	1970	1947	Increase
Motor fuel	3160	2160	1000
Distillate fuel	1350	790	560
Residual fuel	1270	1410	−140
Kerosene	440	280	160
All others	910	750	160
Total	7130	5390	1740

pound, and freedom from dirt and cinders. The present rapid increase in the number of Diesel locomotives is occurring particularly in the larger freight and passenger locomotives, which use from 4000 to 8000 bbl per year of Diesel fuel, as compared with the 1000 bbl used by the small switching Diesels now in common use. We also expect a substantial increase in the proportion of marine Diesel power, and other Diesel uses will also increase—farm tractors, electric power plants, smelters, and miscellaneous uses.

These considerations have led to the projection of domestic demand for petroleum products in 1970, as set forth in Table 4. Also shown are comparable figures for the year 1947. It will be noted that an increase in demand for petroleum products of 31 per cent over the next 23 years is predicted, compared with a fourfold increase over the past 25 years. Of particular interest is the continuing expansion in demand for motor fuel and distillate fuels, and the diminishing demand for residual fuel. This latter point primarily concerns those who are interested in the industrial use of fuel, and warrants further discussion.

Residual fuel oil, such as is used in large industrial installations, is normally produced as a by-product in the manufacture of gasoline, kerosene, Diesel fuel, and so forth. In general, the yields of residual fuel oil have been dictated by the techniques available for refining. Modern technology has placed at our disposal such processes as catalytic cracking, whereby gasoline and distillate-fuel yields can be increased at the expense of residual fuel oil. Processes are even available whereby petroleum can be refined completely to gasoline and distillate fuels, with no production of residual fuel oil. Under present circumstances, however, such a refining pattern would not be warranted.

Despite the availability of such crude-conserving techniques, the current demand for residual fuels is such as to require the deliberate diversion to residual fuels of crude-oil fractions capable of refining to lighter products. With ever-increasing demands for petroleum and with continually rising costs for locating and producing crude oil, it may be expected that in the future the price of petroleum will establish itself at such a level that the deliberate diversion of crude to residual fuel oil will be uneconomical. It will then become necessary for other fuels particularly coal, to assume an increasing proportion of the nation's industrial-fuels load. Such a movement will be in the nation's interest and will lead to the conservation of petroleum for the production of liquid fuels for use in fields where there are no satisfactory substitutes. Therefore, it is our feeling that engineers in planning future industrial installations should look to a gradually decreasing supply of residual fuel oils despite the indicated future expansion of the petroleum industry.

It has been brought out that, by 1970, 7,130,000 bbl a day of crude oil, or its equivalent, will be required to meet the demand. Where, then, is all this liquid petroleum to come from?

PETROLEUM SOURCES

It can be said that the United States currently is producing more liquid petroleum than ever before. The average daily demand during 1947 was met by crude-oil production averaging more than 5,000,000 bbl per day, plus about 357,000 bbl of natural gasoline and benzol, plus imports, mostly from South America, of about 430,000 bbl. These imports more than balanced exports of finished petroleum products. Domestic production of crude oil in October, 1947, reached 5,230,000 bbl per day, nearly 6 per cent over the war peak production. Furthermore, natural gasoline extracted from gas has shown even greater increases. In spite of these higher production figures, proved crude-oil reserves increased 5 per cent between 1945 and 1946, and reserves of natural gasoline, condensate, and the like, rose still more. Total proved reserves of both crude and condensate stood at 24,227,000,000 bbl at the end of 1946.

It remains to be seen whether the race on the part of oil men to find and produce more crude petroleum in this country can keep pace with the ever-increasing demand for liquid fuels. We have imported some oil from South America for years and can import more. As is well known, American oil companies are also striving to develop large new supplies in the Middle East and to install pipe lines to bring these supplies to market. The lushness of the Middle East oil fields is amazing. A daily production of about 885,000 bbl is being obtained there from 208 wells. Some single wells have produced as much as 3,000,000 bbl per year. Only two dry holes were drilled last year. It has been estimated that production can be doubled by 1953 by drilling only 100 new wells per year. To develop the Middle East production further will require steel and equipment from the United States, but such development is justifiable from the standpoint of our own national economy, even if the exporting of equipment means foregoing the immediate development of additional domestic reserves.

If Europe is to survive, it will have to get oil from somewhere and, until it can draw more from the Middle East, it will continue to draw on the Western Hemisphere. In other words, Europe must continue to diminish the very reserves upon which we have to place our main reliance, unless foreign crude production can be increased markedly.

In order to meet our domestic demand for products in the future, we must both stimulate our own producing industry to the fullest extent and also import some additional oil. These two facts have been cited in many enunciations of policy by government bodies and by industrial groups.

It is our opinion that, for many years to come, we may place main reliance on our domestic petroleum reserves and that in peacetime we shall be able to import such additional quantities of petroleum as may be needed. Obviously, sound national policy indicates that we should not permit our domestic reserves to fall to a low ebb merely to avoid importing foreign crude oil. In arriving at a suitable level for foreign imports, cognizance must be given to the problems of national defense which will arise in the event that peacetime imports are cut off. This subject is under study by military and petroleum-industry personnel.

SYNTHETIC LIQUID FUELS

No longer must we rely exclusively on either domestic or foreign petroleum for liquid fuels. Liquid fuels can be produced synthetically from such raw materials as coal or natural gas, and petroleum can be obtained by extraction from shale or tar sands. If crude oil becomes sufficiently scarce to justify the necessary process developments, we can turn to our coal and natural-gas reserves to supply our liquid-hydrocarbon fuels for hundred of years. However, the commercial use of these sources can only be brought about painlessly and soundly from the economic standpoint if the practical development occurs over a long period of time.

The futility of relying on the hurried construction of plants to synthesize petroleum from these other natural resources is immediately apparent. The most likely first source of synthetic liquid petroleum is natural gas. The cost of a plant to produce liquid petroleum from natural gas is currently estimated, depend-

ing on the authority consulted, at $2500 to $4000 or more per daily barrel of liquid product. This assumes a supply of gas is available and ready for delivery to the plants. To produce synthetically only 1,000,000 bbl per day of petroleum, which is less than one fifth of our current needs, would require an investment of many billions of dollars. Assuming the economic urge, plenty of construction materials and man power, and a peaceful environment in which to work, such a program is only possible over a period of years.

Most assuredly, we can synthesize liquid fuels from coal as well as from gas. However, this cannot be done as rapidly or as cheaply, and it cannot be done at all unless new mines are opened and staffed with miners yet to be trained. Bureau of Mines computations indicate that, for the production of 10,000 bbl per day of synthetic petroleum, 6500 tons of coal of 12,000 to 13,000 Btu per lb would be required. To produce 1,000,000 bbl of oil per day from coal would require the erection of plants costing, say, $5,000,000,000; and such plants would consume 650,000 tons of coal a day or about 236,000,000 tons a year. The cost of opening new coal mines is estimated at $5 to $8 per annual ton, which would add another billion or so dollars to the total estimated cost. The nation's entire production of bituminous coal for 1941, was reported at 511,000,000 tons. To produce all of our present 5,000,000 bbl-per-day demand for petroleum products from bituminous coal would necessitate, among other fantastic requirements, twice as much bituminous coal as we mined in 1941; and even that enormous production would leave no bituminous coal to be burned directly as fuel.

The quantities of synthetic liquid fuel which will probably become available in the next few years through the normal peacetime development of our economy will seem very large in terms of the technological achievement involved. To the extent that the operation is regarded as a chemical synthesis, it will give us by far the greatest volume of synthetic product ever produced. But measured in terms of our total requirements for liquid fuels, the fraction produced by synthesis is apt to be small for several decades, and its rate of growth will depend on the law of supply and demand. In any event, it appears unlikely that economics will permit liquid fuels synthesized from coal to compete for markets in which direct use of coal is an alternative.

The production of large quantities of oil from shale and tar sands seems considerably more remote than from synthesis. The processes of separation, particularly in the case of shale, are by no means impracticable, and the construction costs of plants to extract and refine the products may easily be less than for synthesis from coal. But the mining and handling of the necessarily great quantities of shale are bound to be expensive when it is considered that, to get a barrel of crude shale oil, more than a ton of material must be dug up and moved through the plant, and the remainder carted away to get rid of it.

Now what of the future of gaseous fuels? It is noteworthy that, while the consumption of natural gas has increased about as rapidly as that of liquid petroleum, the known reserves of gas have increased more rapidly. Furthermore, while gas can be converted to liquid fuel by synthesis, the total gas reserves could not be diverted to that use. Even if they were, they would afford only a few years' supply of liquid fuel. For normal heating purposes alone, obviously, there is no economic justification for converting gas to distillate fuel oil for use as an alternative to natural gas.

Thus far we have discussed future liquid fuels from the standpoint of quantity only. What quality of fuel may we expect? At the outset, we must consider the trend in development of the internal-combustion engine. Some considerable part of the total technical impetus toward improving the spark-ignited internal-combustion power plant and its fuel, in recent years, has been drawn from the need for improving aircraft engines and heavy-truck engines. A part, at least, of this impetus is being withdrawn. More and more dieselization of heavy trucks is anticipated, and aircraft development—always spurred on mainly by national-defense considerations and financed largely by the Government—seems firmly directed toward jet and turbine-jet power plants.

At the same time, we know that the automobile manufacturers are working on engines that will have higher compression ratios and will require gasoline of higher octane number. Eventually, they intend to turn out cars that will make efficient use of gasoline of 95 research octane number, or even higher. These cars will go farther on less gasoline but, since there will also be more of them, total gasoline consumption in the country will rise. Hence we shall be faced with two simultaneous demands—for higher-quality gasoline, and for more of it.

From the early 1920's until the early 1940's it was possible, through a series of technological advances, to decrease the cost of gasoline while steadily increasing the quality; but the time has come when further substantial quality increases will cost real money. When the average for all the gasoline produced in the country has to be raised to 95 research octane number or above, it will mean upgrading most of the present components of gasoline by high-cost processing. While a certain quality improvement can be realized at low cost through technological improvements in refining, the cost of gasoline must go up as certainly as quality is substantially increased.

Turning to other fuels, we can expect to see an increase in some of the quality requirements of high-speed Diesel fuels. For many years the Diesel engine was considered an omnivorous device which would operate on almost anything. Now, however, interest centers on particular forms of the Diesel engine, from which high speeds and outputs are exacted and which we find are anything but insensitive to fuel quality. The problems of fitting fuels to Diesels are likely to increase; but, with further research, it may turn out that fuels can be used which are not now employed in high-speed Diesels. It appears that cetane number has been overemphasized as a yardstick of quality, and that performance of a Diesel engine in service is by no means indicated precisely by cetane number as now measured. The actual variables to be reckoned with include both engine and fuel characteristics. Many of the performance factors exist only in the service engine itself, and, therefore, fuels must be evaluated in that engine.

Looking ahead, the gas turbine may have an appreciable effect on the demand and quality of liquid and gaseous fuels. Because the blades of the gas turbine are particularly vulnerable to the harmful effects of ash and corrosion, a clean liquid or gaseous fuel seems certain to be required. The quality of the liquid fuel is unlikely to be critical, so long as clean distillates are used. Since combustion may occur quite far removed from the turbine, in most cases there will be adequate opportunity to install devices which improve the burning qualities of almost any hydrocarbon or other liquid.

SUMMARY

In summary, we have seen that the demand for petroleum products has quadrupled during the past 25 years, and that it may be expected to increase another 30 per cent by 1970. By that time, the total demand will exceed 7,000,000 bbl per day. This demand can be met by healthy domestic crude-oil production, some foreign imports, and synthesis from natural gas and coal. The economics of the industry will result in a gradually diminishing supply of residual fuel oil for industrial purposes, and coal will handle an increasing share of the expanding industrial-fuel load. However, enough liquid fuels will be available to meet the demand for purposes most efficiently served by petroleum fuels.

MAGNESIUM CASTINGS—*Their* PRODUCTION *and* USE

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MAGNESIUM casting alloys are distinguished for their low weight, high strength, easy machinability, and other desirable characteristics. These alloys can be fabricated by any of the commonly used foundry methods, such as green sand, dry sand, plaster, permanent mold, and die casting. Experimental work is now being carried out on centrifugal casting. In general, the casting of magnesium alloys by any of these processes is done in the same manner as used with other common metals except in so far as it is necessary to modify the process or materials used because of the light weight and the thermal and chemical characteristics of magnesium.

METHODS OF CASTING

The decision as to the casting method to be used for production of a given part will be based upon a number of factors. In general, parts of any size and complexity of design can be made by the sand-casting method. Fairly simple castings for which the demand is for quantities of over a thousand pieces may be considered for permanent-mold work. Die casting is a possible method for use when the casting sections are relatively thin and uniform, and when the quantity requirements are high, perhaps a minimum of from 1000 to 5000 pieces depending upon the casting. Usually, production costs are lowest on die castings and highest on sand castings, but this may not be true for certain parts.

In common with most other pure metals, pure magnesium ordinarily is not considered as a structural material. When alloyed with suitable amounts of aluminum, zinc, and manganese the properties of the alloys are comparable with those of the aluminum alloys. The total of added metals is usually about 10 per cent, and the alloys have a specific gravity of about 1.8, only slightly heavier than the pure metal. The composition, properties, and uses of the common casting alloys are given in Table 1.

Melting of magnesium alloys usually is done with flux protection to prevent oxidation of the molten metal by air. An exception to this is in the die-casting operation where clean ingot metal can be melted in a flux-free pot in which the metal is protected with sulphur dioxide. The fluxes used in various melting methods vary somewhat in composition, but they generally contain magnesium and other chlorides as major constituents. These cause the fluxes to be hygroscopic and make necessary some of the precautions observed in the melting processes.

The sand- and permanent-mold castings are commonly used in both the as-cast and heat-treated conditions. Die castings are not usually heat-treated, although in a few cases this has been done. The heat-treating schedule used depends upon the service requirements of the castings. Solution heat-treatment at 730 to 785 F, depending upon composition, gives the maximum toughness and elongation; while aging at 350 to 425 F after solution heat-treatment gives maximum hardness and yield strength. Stabilization heat-treatment at 500 F gives relief of casting stresses when applied to as-cast parts and gives approximately the same properties as aging when applied to solution-heat-treated castings.

Magnesium-alloy castings may be heat-treated in either gas-fired or electric furnaces of the circulating atmosphere type. Electric or indirect-fired furnaces are preferable for heat-treating if the temperatures are above 750 F. To minimize surface oxidation, it is recommended that about 1 per cent sulphur dioxide be maintained in the atmosphere of such furnaces used for solution heat-treatment. Magnesium casting alloys are slightly plastic at solution-heat-treating temperatures and so must be placed on the heat-treat rack in such a manner as to receive adequate support.

Sand Casting. The same general foundry practice is used in magnesium sand foundries as in those casting other metals.

TABLE 1 COMPOSITION AND PROPERTIES OF COMMON MAGNESIUM CASTING ALLOYS

Dow-metal alloy	ASTM no.	Nominal composition per cent Al	Mn	Zn	Mg	Form	Typical mechanical properties[a] Condition	Tensile strength, psi	Yield strength, psi[b]	Elongation in 2 in., per cent	Bhn	Remarks
H	AZ63	6.0	0.2	3.0	Remainder	Sand and permanent-mold castings	As-cast	29000	14000	6	50	General-purpose casting alloy
							Heat-treated	40000	14000	12	55	
							Heat-treated and aged	40000	19000	5	73	
C	AZ92	9.0	0.1	2.0	Remainder	Sand and permanent-mold castings	As-cast	24000	14000	2	65	Maximum strength and hardness
							Heat-treated	40000	16000	10	63	
							Heat-treated and aged	40000	23000	2	84	
R	AZ91	9.0	0.2	0.6	Remainder	Die castings	As-cast	33000	22000	3	60	General purpose alloy

[a] Separately cast ASTM test bars.
[b] Strength at 0.2 per cent deviation from modulus line.

[1] Magnesium Division, The Dow Chemical Company. Mem. ASME.
[2] Magnesium Division, The Dow Chemical Company.

Contributed by the Metals Engineering Division and presented at the Annual Meeting, Atlantic City, N. J., Dec. 1–5, 1947, of The American Society of Mechanical Engineers.

FIG. 1 POURING OF A MAGNESIUM SAND CASTING
(Mold flasks shown are assembled from cast magnesium panels.)

Special features include the flux used for protection during melting, the inhibitor used in the molding sand, and the care to avoid turbulence during the flow of metal through the mold passages. Magnesium alloys are light and lose heat rapidly, necessitating generous venting, particularly from thin sections. Most foundries use an open synthetic molding sand with an AFA permeability of about 100. Natural molding sands with a permeability of about 40 are used to a limited extent and mostly on small castings. The inhibitor used in the molding sand is to prevent reaction between the molten metal and the moist sand. It consists of from 4 to 10 per cent of a mixture of sulphur, boric acid, and a fluoride, usually ammonium silicofluoride. Cores are made from an open sand and most foundries are using a urea-formaldehyde binder because of easier knockout characteristics. A small amount of sulphur, boric acid, and potassium fluoborate in the core sand protects the casting from oxidation.

The metal for pouring sand castings is melted and cast from crucibles made of welded steel plate. These crucibles are usually spray-coated with aluminum to minimize external scaling. Using flux for protection, the metal is either melted in a large premelt unit from which it is poured into the casting crucibles, or is melted directly in the crucibles. After melting, the metal is refined by stirring with crucible flux or by bubbling chlorine gas through the melt at about 1350 F. It is then given a grain-refining treatment and cast at the selected temperature, usually between 1300 and 1550 F, Fig. 1.

Molds for magnesium castings must be so made as to avoid turbulence and resistance to metal flow. The conventional gating method is to take the metal to the lowest point in the mold, pass it through a skim gate and steel-wool filter, and then bring it into the bottom section of the casting, either through a continuous web gate or through a number of small finger gates. A newer and improved method of gating is to place a tube made of the skim gate in a vertical well which is connected to the casting with a continuous slot gate. The metal is brought into the tube from either the bottom or the top and fills the casting cavity progressively from the bottom up. This method allows the casting to be poured without passing the metal required for the upper part and the risers through the lower part of the casting, and thus avoids heating up the sand and creating hot spots which are hard to feed during solidification. The use of this gating method enables sound clean castings to be made with fewer chills and less riser metal than the bottom-gate method.

Permanent-Mold Casting. In considering the suitability of permanent-mold casting as a production method, attention should be given to the design of the part, and quantity requirements. The part should be of fairly simple shape, uniform wall thickness, and without undercuts or complicated internal coring. Production runs of 1000 or more pieces will usually justify this method of casting. Because permanent-mold castings can be made to close tolerances and good finish, it frequently will be possible to eliminate or reduce subsequent machining operations.

The metal for permanent-mold casting is either melted directly in the casting pot or, on large operations, is melted in a separate unit and the casting pot is serviced with molten metal at the proper temperature. In either case, enough flux is kept in the casting pot to maintain the necessary protective film and keep the metal in clean condition. Metal for pouring is dipped from the pot with a bottom-pour ladle, designed to prevent flux contamination of the castings.

The molds can be made from a good quality high-carbon gray cast iron. Usually about $^1/_2$ to 1-in. thickness of metal should be allowed behind the cavity. Cores may be made of sand or steel, depending upon the complexity. Ordinary machine steel will give good service for cores, but it is

usually better to use a nickel-free stainless if a large number of castings is to be produced. The draft on both mold and core surfaces should be 5 deg if possible, but 2 or 3 deg can be used on some castings. Ejector pins will usually be necessary. Most magnesium alloys are hot-short when first removed from the mold and require careful handling. Mold coating and general practice will be similar to that used for making aluminum castings. The molds may be operated by any one of several methods which will be determined by the production requirements. It may be a simple book mold, or may be operated manually by a rack and pinion, or by an air or hydraulic cylinder.

Die Casting. Most pressure die casting of magnesium is done by the cold-chamber process in high-pressure machines. While pressures as high as 50,000 psi are sometimes used, the average range is from 4000 to 15,000 psi. The machines generally have die-locking pressures of 400 to 500 tons, but smaller machines are satisfactory for small castings. The plunger speed and the cycle of die operation are both very important in the production of good uniform-quality die castings. Plunger speeds of 70 to 350 fpm are used; the higher speeds in making thin-wall castings in which it is necessary to fill the die quickly, and the lower speeds in conjunction with higher injection pressures to produce the best-quality castings from the standpoint of internal soundness.

The metal-handling practice is different for die-casting than for the other casting methods. Since small quantities of metal must be dipped from the pot at short intervals of time, it is not convenient to use flux for metal protection. The molten metal is held in the casting pot under a protective atmosphere of sulphur dioxide. This atmosphere is held under a cover so placed as to enclose substantially the area over the molten metal. The best metal-handling practice is to melt and refine all metal in a separate unit and then to service the casting pot with clean molten metal at a constant temperature. Die-casting scrap, because of the contamination introduced, cannot be satisfactorily melted in the casting pot. Clean ingot can be fed into the casting pot, but best results are obtained by premelting all metal. Continuous generation of the protective atmosphere and care in keeping the inside of the casting pot and cover properly cleaned of dross will insure safe and satisfactory operation of this unit.

The dies are made either of carbon tool steel or a tool steel of the 5 per cent chromium, 6 per cent tungsten type, depending upon whether they are for short or long runs. Alloy-steel dies should be heat-treated and drawn to a temperature of about 1100 F.

The metal is usually cast at about 1200 F, with 1300 F as the maximum. The dies run at temperatures up to about 600 F. They are heated or cooled as needed to maintain the proper temperature. It is important that the correct die and metal temperatures be established for each casting and then closely controlled.

The die design, of course, will be dependent upon the size and type of casting and the equipment to be used. In general, the design will be similar to that used for aluminum die castings. Generous fillets and careful blending of section changes should be provided. The metal must be brought into the cavity with a minimum of turbulence and with adequate venting. The flowing of large amounts of metal over small die areas should be avoided.

USES FOR MAGNESIUM CASTINGS

The outstanding characteristic of magnesium is, of course, its remarkably lightweight, which is only one quarter that of iron and but two thirds that of aluminum, its companion light metal. The availability of these light and strong structural materials made possible the unprecedented production of powerful aircraft and air-borne equipment, without which the recent war perhaps could not have been brought quickly to a successful conclusion. The use of magnesium castings in a wide variety of military applications thoroughly established them as structural materials capable of withstanding the most severe conditions of service. Although the applications now developing are different, service records have been built up which can give designers confidence in the expected performance of the material.

Design. Magnesium-alloy castings possess many properties which make them desirable for use in a wide range of applications. The more important properties of interest to the designer may be listed as follows: (1) High strength-weight ratio; (2) easy machinability; (3) nonmagnetic; (4) nonsparking; (5) stability under most conditions of use.

The composition and properties of the usual cast magnesium alloys are given in Table 1. In combination with the low specific gravity of about 1.8, these properties provide the highest strength-weight ratio of the common casting metals. The compositions listed have proved satisfactory for all ordinary operating conditions. However, for stressed applications to operate at temperatures near 400 F, or higher, alloys with higher strength retention have been developed. These contain cerium in amounts up to 6 per cent and may prove useful for increased design requirements in turbojet engines and pistons for internal-combustion engines.

An important characteristic of magnesium castings is their easy machinability, which is rated as superior to that of any other metal. This frequently is a deciding factor in choosing magnesium, as the finished cost of the article may be lowered by so doing. In one example of a lubricator housing, the machining costs were reduced 60 per cent below those for cast iron, and the total final cost was 22 per cent less. The nonsparking and nonmagnetic properties occasionally have proved useful in special applications. The stability of magnesium is now well established through many exposure-test programs and through the successful experience with many thousands of military parts during the war. If reasonable care is exercised in choice of application and in applying ordinary protective measures, very satisfactory service will be obtained.

The design of magnesium-alloy castings is usually about the same as for other castings. While good design features are important with magnesium, they really are only those which should be used with all cast materials. To prevent stress concentration leading to fatigue failure, sharp internal corners, gouges in surfaces, and other surface irregularities in stressed areas should be avoided. Ample fillets should be used around bosses, but not to the extent that the mass is such as to cause draws and cracks. Bosses should be located so they can be risered or chilled to secure maximum soundness if it is desired. The thin and heavy sections must be so blended as to avoid a sharp transition line. Wall thicknesses in sand and permanent-mold castings preferably should not be less than $^{3}/_{16}$ in. but may be $^{5}/_{32}$ in. in limited areas. In die castings, walls may go down to 0.050 in. Additional details of design are available in the technical literature and in manufacturers' publications. A practice which will improve the quality and lower the cost of producing castings is for the engineer and the foundryman to get together early in the development of the casting design. When this is done, the most castable design can be developed, and the foundry will not need to spend excessive time and labor to work out a special foundry practice. The desirability of early and continued co-operation between these two groups cannot be emphasized too strongly.

Aircraft. As expected, the greatest wartime use for magnesium castings was in aircraft. Fortunately, sand-cast magne-

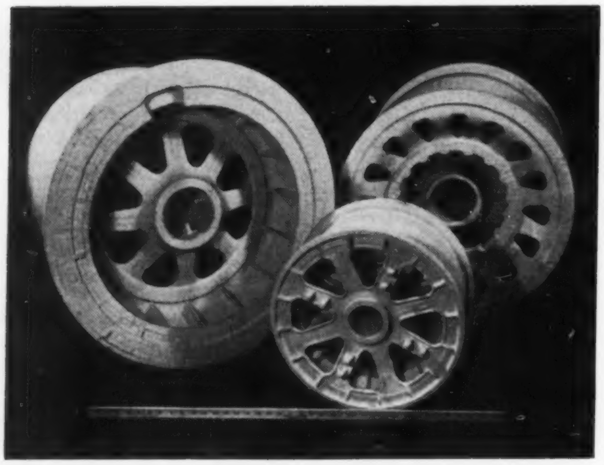


FIG. 2 MAGNESIUM AIRCRAFT-LANDING-WHEEL CASTINGS
(Largest casting weighs about 170 lb.)

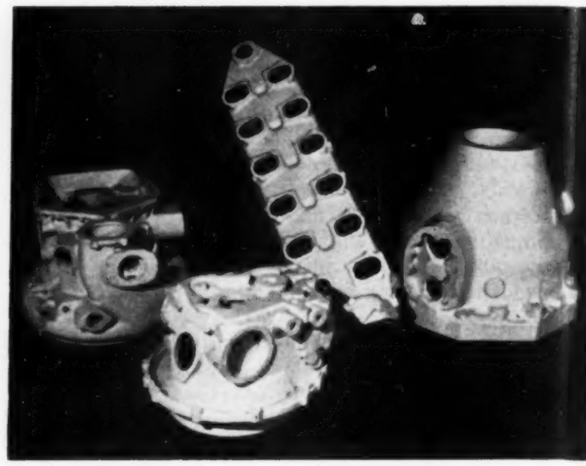


FIG. 3 MAGNESIUM AIRCRAFT-ENGINE CASTINGS
(Casting at left weighs 43 lb.)

sium landing wheels and engine parts were well developed during the 1930's, and it was possible to incorporate them into new military designs with adequate assurance of performance. Except for amphibian use, practically all landing wheels were finally being made in magnesium, Fig. 2. With improved fabrication techniques, tail wheels and landing wheels for light observation planes were made from magnesium die castings.

Every principal American aircraft power plant used numerous magnesium sand castings for parts such as the blower and supercharger housings, gear cases, front and rear sections, carburetor bodies, ignition harness, oil sumps, air-induction system and numerous small parts and covers, Fig. 3. By 1944, when the production peak was attained, a number of these parts were being made as permanent-mold castings or die castings. Many of these applications were of critical character and required the utmost in quality and dependability.

Of particular current interest is the extensive use of magnesium parts in turbojet-engine construction. Main frames and the housings and miscellaneous parts of the air-compression system are built almost entirely of magnesium castings, Fig. 4. For example, the famous I-40 engine incorporates 41 castings with a rough weight of 480 lb. It should be noted that, while a standard casting alloy, AZ92, has proved satisfactory for most turbojet applications, increasing design requirements for alloys to operate at temperatures up to 600 F can be met by a magnesium alloy containing approximately 6 per cent cerium and designated as E6.

In addition to aircraft wheels and engine uses, numerous magnesium castings were employed as airframe structural parts and in a wide variety of accessories. In the latter field, especially heavy use was made of die castings. One company alone, specializing in the highest quality of aircraft starters, hydraulic systems, and control instruments, used approximately 13 million magnesium die castings during the war, convincing proof of their utility.

All of the foregoing wartime aircraft applications for magnesium castings are being continued in present aircraft manufacture. Of more passing interest to the layman, but undoubtedly of continuing interest to those charged with responsibility for

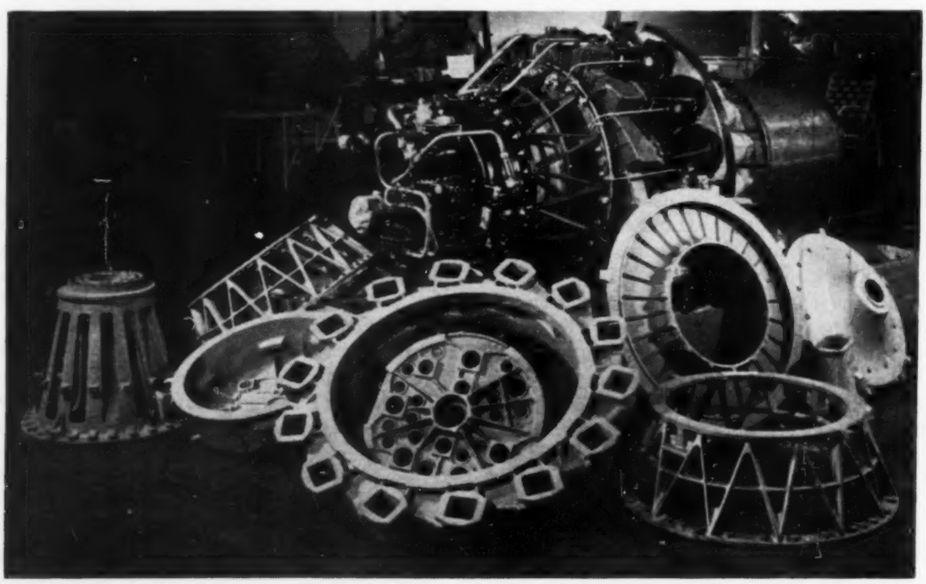


FIG. 4 ALLISON TURBOJET ENGINE AND PRINCIPAL MAGNESIUM CASTINGS USED IN THE CONSTRUCTION

our military development, are the uses of magnesium in airborne military equipment. Gun turrets and other attached ordnance equipment made wide use of magnesium, while increasing use was made of it in air-portable ordnance and construction equipment. In all probability, the latter use will expand into commercial fields for the exploration and development of hitherto inaccessible areas.

Transportation. While the lightness of magnesium is vitally important to the aircraft industry, other transportation industries are becoming increasingly weight-conscious, as will be quickly evident on glancing through the advertising pages of their trade magazines. The advantages of increased pay load are obvious to anyone, of course, and the problem becomes one of how to secure it at a cost low enough to insure operating economy over the life of the equipment. The use of light metals, including magnesium castings, in well-engineered designs is a natural answer.

Magnesium sand-cast wheels for passenger automobiles have been tested successfully by several prominent manufacturers, who report smoother riding and easier steering on rough roads and remarkably decreased tire wear. The weight is less than one half that of the steel wheel, and the strength and safety factors are as good or better than with steel, Fig. 5. The higher cost of magnesium sand castings, however, compared to steel stampings has proved to be a serious obstacle. The solution to this problem may be found in the use of die castings, which can be fabricated more cheaply than sand castings, and experiments are now under way in this direction. Another automotive possibility is the die casting of entire doors, securing lowered fabricating costs, as well as lighter weight, compared to steel. A proved prewar application in passenger cars is the use of hundreds of thousands of die-cast magnesium end plates for starting motors and generators.

In other branches of the transportation industry, sand-cast magnesium brackets, spacers, and corner caps have been used in bus and truck construction. Heavy castings have been used for fifth wheels in trailer operation and for the landing gear supporting the front end of the trailer. Die-cast bus-seat frames are being developed, another example of combining a weight saving with lower fabricating costs, compared to the conventional sheet-metal assembly. Sand-cast truck and bus wheels have long been used in England and other European countries and are currently being investigated here. A part closely associated with the wheel is the hub upon which it is mounted. In one cast-magnesium design, the weight is 25 lb, while that of the steel counterpart is 52.5 lb, a saving of over 50 per cent. Experimental sand-cast hubs have been in completely successful use for two and a half years on a 25-ton platform truck used in the oil fields, where such trucks are frequently overloaded. Typifying the usual design changes, in Fig. 6, are illustrated the thicker sections used when cast magnesium replaces cast steel in a brake shoe with a 50 per cent weight saving. Walls and ribs were increased but it was possible to retain the outside dimension of the part.

In railroad operation, mounting fuel and personnel costs undoubtedly will stimulate increased interest in lighter-weight equipment to secure the maximum pay load out of the total tonnage hauled. As perhaps the largest industrial users of solid and liquid fuels, the railroads might be said to have a public responsibility to conserve them by operating at the best possible efficiency. While it cannot be said that any parts are in production yet, preliminary investigations indicate that truck side frames and bolsters are definite possibilities as magnesium sand castings, with a weight saving of around 50 per cent.

Materials-Handling Equipment. Cast magnesium parts are desirable in such items as are handled by paid labor where

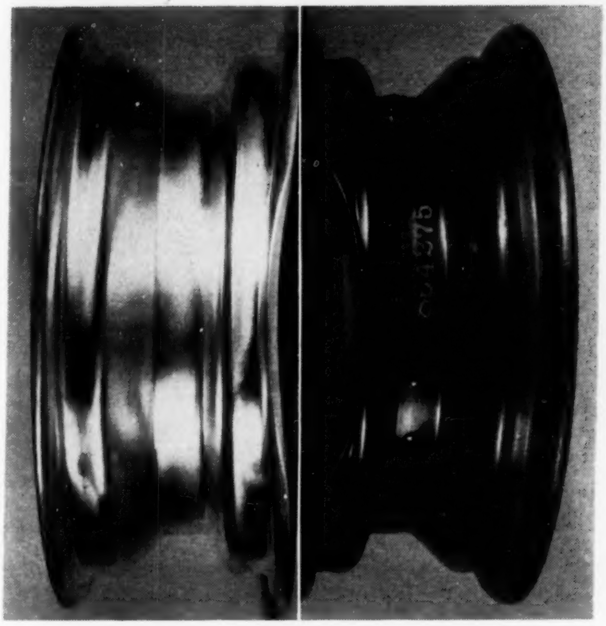


FIG. 5 CAST MAGNESIUM AUTOMOBILE WHEEL SHOWN AT LEFT WEIGHING 9 LB, AND STEEL WHEEL, WEIGHING 20 LB
(Results of impact test by dropping a 200-lb weight 26 in. onto the rim of each.)

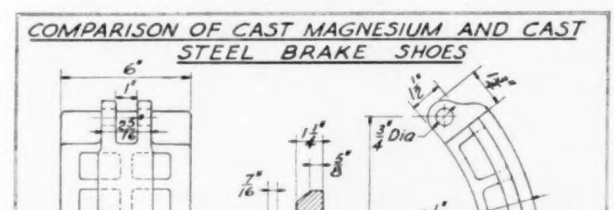


FIG. 6 TYPICAL REDESIGN OF A STEEL PART AS A MAGNESIUM CASTING

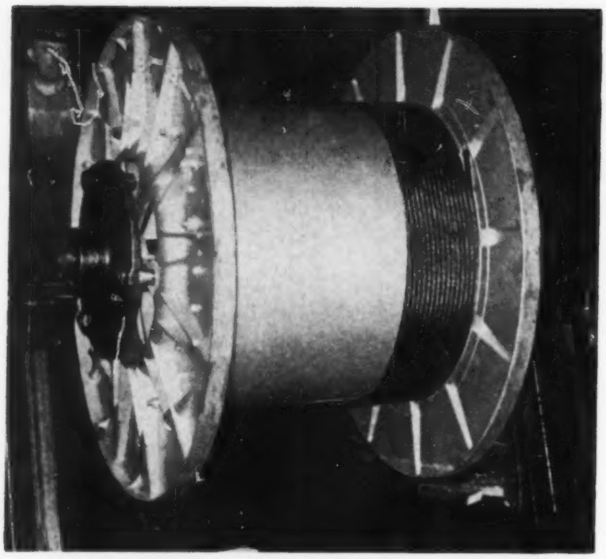


FIG. 7 EXPERIMENTAL MAGNESIUM CABLE REEL UNDERGOING TESTS AT PLANT OF JOHN A. ROEBLING'S SONS COMPANY

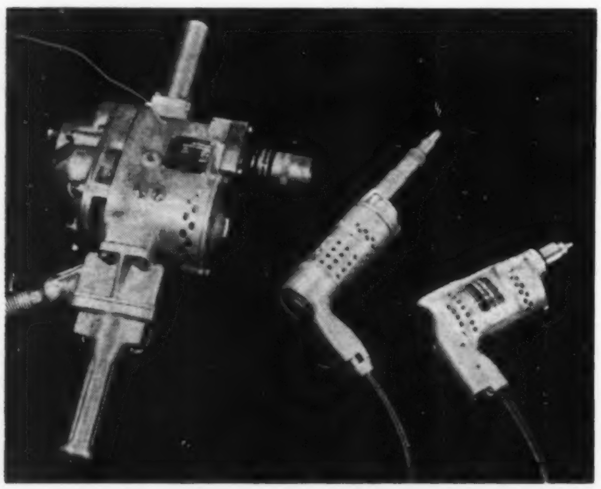


FIG. 8 PORTABLE TOOLS USING CAST MAGNESIUM HOUSINGS AND HANDLES

(Independent Pneumatic Tool Company.)

lessened worker fatigue or increased production are worth paying for. This was demonstrated several years ago by the use of cast magnesium hand trucks for handling heavy drums. While somewhat more expensive, due to small-scale production, the trucks were only one half the weight of the fabricated-steel trucks. They were, of course, more popular with the workmen, who demanded and received complete replacement of the heavier trucks. Other similar satisfactory applications for magnesium castings are in dollies for handling heavy machinery and in home-appliance movers.

Frequently, other factors than the human element will be important. For example, large cable reels made up mainly from magnesium castings are a new development and are lighter than either steel or wood reels and more durable than the latter, Fig. 7. Comparative weights for 60-in-diam × 32-in. × 32-in. reels are wood 550 lb, steel 350 lb, magnesium 238 lb. Wood reels last about five cross-country trips or around 2 years, while the life of the steel or magnesium reels is estimated to be on the order of 50 trips or upward of twenty years. While initially more expensive, it is anticipated that the savings in freight will make their use very attractive and practical.

Of similar nature are the spools or "beams" used in textile mills. These are made with cast end flanges joined by a central barrel of tubing. The smaller flanges are die castings, while the large ones, which may be as much as 30 in. diam, are either sand or permanent-mold castings. The use of magnesium for these parts insures the lightest weight for easy handling, fast winding, and freedom from the splintering which frequently occurs with wood and results in snagging of the thread.

Portable Tools. Small and portable tools are making increasing use of magnesium castings in their construction. Prewar applications in electric and pneumatic drills and hand tools have revived, of course, while many new ones have been developed, Fig. 8. It has been noted that there is a trend toward the use of permanent-mold or die castings in portable-tool assemblies, a fact possibly indicative of growing acceptance of magnesium for such use.

Typical additional tools of this class which might be mentioned are levels, safety tongs, brick tongs, mine drills, and chain saws. Almost any tool or portable piece of equipment which must be carried or used manually can benefit from the incorporation of magnesium castings in the design. Compared to iron or steel parts, a saving in weight of from one half to three quarters is possible, while as much as one third frequently can be attained in replacing aluminum.

Production Equipment. It has been found advantageous also to use magnesium castings in production equipment which must be handled many times each day, resulting in lessened worker fatigue. An example of this is foundry snap or slip flasks for which magnesium castings have been used successfully for many years. Large flasks, assembled from sand-cast panels, also have proved out well. In some cases, the weight saving has been so great, running into the hundreds of pounds when iron was replaced, that larger molds could be made on the molding machines, thus, in effect, increasing their capacity and nullifying any additional cost. Other foundry uses for magnesium castings, both of which have stood the test of service, are permanent-mold-cast bottom boards and core plates. A proposed application somewhat similar to the last is a die- or permanent-mold-cast cement-block pallet. It should be noted that the alkalinity of the cement has no effect on magnesium.

An interesting use is for die-cast magnesium bakers peels, the flat paddles used for insertion and removal of pans from production ovens. The magnesium is light in weight, about 2.5 lb, but its unique characteristics here are freedom from checking and charring, which limit the life of a wood peel to about 2 weeks, compared to a year for the metal peel, and just the right friction or "stickiness" in contact with the baking pans.

Very often the use of magnesium for reciprocating or moving parts of production machinery will result in lessened vibration and thus permit higher speeds and output. Textile looms, packaging machines, and printing presses are but three examples. As an indication of the possibilities in this direction, it may be pointed out that in Germany in 1938, about 300,000 lb of magnesium per month went into textile applications, considerably more than was used in the United States at the time in all applications in all industries. This was not due to the scarcity of other metals in Germany, as some have supposed, but rather to an early recognition of the production advantages accruing through the use of the lightest structural metal.

Electrical Equipment. In the electrical industry many op-

portunities exist for saving weight. In the case of a 5-hp electric motor, revised for aircraft use, magnesium sand castings for the main frame, end bells, and fan reduced the weight of these parts from 21 lb in cast iron to 5.1 lb, a saving of 75 per cent. Magnesium permanent-mold castings recently have been introduced in the transposition brackets to eliminate interference between communications carrier circuits, Fig. 9. The light weight permits them to be hung directly on the wires at the optimum intervals. Magnesium die castings were used extensively in radar, radio, and other electrical instruments during the recent war, and it seems logical that applications will be found for them in the electrical-control and communications fields.

Consumer Goods. The use of magnesium castings in consumer goods is only just beginning to develop significantly. Necessarily prohibited during the war, magnesium has been considered for many such applications during the past two years, in a period clouded by postwar material and product scarcities. Many of the proposed uses require a trial period, not so much for the materials, but for the basic article itself. Of the countless new designs being brought out, those combining the most suitable materials, sound engineering and manufacturing, and good merchandising will survive. The following examples may be considered as typical of the several consumer fields in which magnesium castings are being used with every prospect of permanent success:

One of the most promising of the new applications is in the main metal frames or string plates in piano construction. Formerly of cast iron, these were responsible for the heavy immovability of pianos so much deplored by the American housewife. In one make, the use of magnesium has reduced the weight of the completed piano by 150 lb or about 40 per cent. A magnesium plate also has made possible the construction of a small apartment or practice piano weighing only a total of 80 lb. The weight saving, in all cases, is obtained without sacrifice of tonal quality. An important though secondary benefit is the fact that the machining time is but one half of that required for cast iron. While the plates to date have been magnesium sand castings, the large potential requirements make permanent-mold castings the logical choice for full production.

A few magnesium sporting goods items have been introduced successfully, including a sand-cast catcher's mask, a hollow-handled table tennis bat, and a child's sidewalk bicycle assembled from die castings. Die castings also have had considerable acceptance for popular optical goods, including camera bodies and parts, and binocular frames (Fig. 10). The latter use was fairly well established before the war and is rapidly regaining its position.

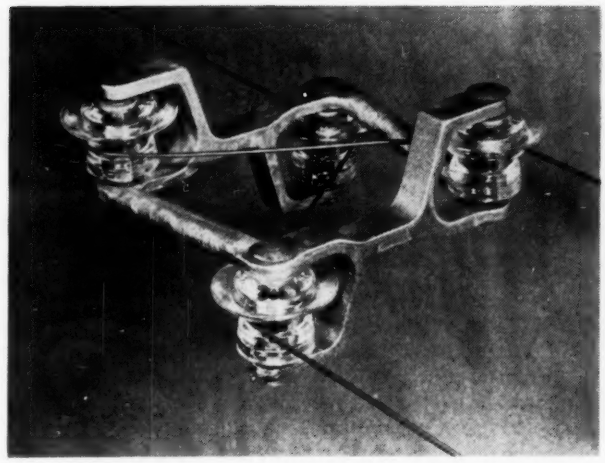


FIG. 9 PERMANENT-MOLD CAST-MAGNESIUM TRANSPOSITION BRACKET

(Transandean Associates, Inc.)

CONCLUSION

In the foregoing discussion it will be evident that the applications using magnesium castings do so because of their lightweight. Many existing articles are heavy just because they have always been made of heavy materials. The replacement of heavy castings on present machines or equipment with magnesium helps to improve portability, lessen worker fatigue, and speed up operations, and, in some cases, to decrease maintenance trouble. The maximum advantages will be realized however, only when the designer starts from the beginning with a new concept of the possibilities of real weight reduction and builds around the many valuable characteristics of magnesium castings. Using the magnesium alloys and casting techniques which are now available, lightweight with its obvious advantages in many fields is obtainable with adequate assurance of strength and durability.

FIG. 10 DIE-CAST MAGNESIUM FRAMES FOR FIELD GLASSES

(Airguide.)

Measuring OPINIONS, ATTITUDES, *and* CONSUMER WANTS

By FREDERICK F. STEPHAN[1]

SOCIAL SCIENCE RESEARCH COUNCIL, NEW YORK, N. Y.

THE most difficult problems facing management today are not those of materials and machines but those involving human behavior. They appear in the relations of employers and employees. They affect productivity and prices. They dominate management's relations with the actual or potential consumers of its products and services, people who in their aggregate response to the product constitute its market. To cope with these problems of human behavior, management has made increasing use of specialized services for advertising, public relations, personnel work, market research, and other functions concerned with people rather than with materials or technological processes. In spite of the great development of these services, it is fair to say that the human factors in business and industry are still inadequately understood and managed. As a consequence, both wages and profits are lower than they could be, and important human wants are not adequately satisfied.

BASIC LAWS OF HUMAN BEHAVIOR NOT UNDERSTOOD

Greater success in solving the human problems will result from further development of these specialized services but the amount of progress which can be made in this way is limited by our inadequate knowledge of the fundamental processes and basic laws of human behavior. We have surveys of what people say they believe or want, and we have measures of which products they prefer and how much they consume, but we have very little information about the way in which they have come to think or demand or prefer or consume what they do. Still more important, we do not know accurately enough just how strongly they hold their attitudes and consuming habits, and what methods would bring about what changes in their wants and behavior. But this is precisely what management needs to know in order to solve its problems efficiently.

The lack of such fundamental knowledge of human behavior, and of the facts necessary to apply it in particular situations, leads to faulty decisions and at times to very serious losses. By contributing to the effectiveness of actions taken by management, and hence reducing losses and increasing gains, investments in research into the fundamentals of human behavior will pay great dividends.

Where can management find the research results it needs? Most basic research into these problems has been done by psychologists, economists, sociologists, anthropologists, and others who are often grouped with them under the general title of "social scientists." Their work is done in universities, in independent research organizations, and in special research units within business corporations, government agencies or private associations. They have made notable contributions to our knowledge of human behavior but they would be the first to agree that their achievements to date are only a meager beginning compared with the problems that lie ahead of them. They are dealing with very complicated systems of causes, yet much less effort has been devoted to their work than to the study of materials, machines, structures, and industrial processes.

SOCIAL-SCIENCE RESEARCH

Within the last ten years or so there has been a rapid increase in social-science research under the stimulation of the depression and the war and their various consequences. Throughout this period there has been a shortage of personnel adequately trained for fundamental research in social science. The shortage is most acute at the present time. Personnel is being drawn away from research work to perform other functions in business, government, and education. Hence management must concern itself with increasing the supply of research personnel by supporting the training centers, establishing fellowships and research projects, co-operating through trade associations and otherwise in industry-wide research programs which include training opportunities.

STUDIES THAT SHOULD BE MADE

The study of attitudes, opinions, and wants is a very fertile field for the development of basic social science and the training of research workers. Surveys of opinion are now conducted quite effectively, although many of the problems of measuring opinion are still unsolved. Market research has been successful in charting consumer preferences, and the demand for products. Here again more work remains to be done before the measurements are fully satisfactory. Many fundamental problems have been neglected to date, among them the following:

Individual Motivations and Preference Systems. How is a given preference or want related to other preferences and wants in the same individual? How can a want be changed by influences that involve other wants? How stable and consistent is a preference system? How effectively does it determine the individual's behavior? How well can one predict future behavior from present attitudes and wants? How far can individual differences be brought into line with standardized products and standard products with the variety of preferences?

Relation of Wants and Preferences to Inherent Properties of Product. How sensitive are wants and preferences to the physical, chemical, and other inherent properties of the product? What changes in inherent quality will be noticed or have an effect on consumption? What quality characteristics are imputed to a product apart from those actually possessed by the product? What factors determine preferences and how do they operate?

Group Behavior and Markets. How do preferences and wants change in the face of fashion trends, fads, panics, depressions, inflation, and new inventions? How can new products be launched successfully? How can the relation of demand to price and quality characteristics be measured for prices and qualities widely different from those prevailing in the market?

[1] Director of Studies of Sampling.

Contributed by the Management Division and presented at the Annual Meeting, Atlantic City, N. J., December 1-5, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

How far do leaders influence opinions and wants, and how far are they shaped by the whole population?

Methods of Measurement. How accurate and reliable are interviews and questionnaires in measuring attitudes and wants? What biases are introduced by the observer or interviewer? How can one obtain an adequate sample of people and assure accurate representation of the entire population or some particular group or market? How can one reduce the cost of measurement and sampling without sacrificing necessary accuracy?

These are merely suggestions of general problems that can be studied in relation to particular products, services, or attitude situations. If they are studied properly the results will fit together with results of other studies to build up the scientific knowledge of attitudes and wants that is needed by management.

SOME GENERAL DIRECTIONS

It is not possible to prepare detailed blueprints of fundamental research into attitudes and wants. Like detective work, it must proceed by finding and following clues, sifting evidence critically, and setting up crucial tests of the validity of each conclusion. However, a few simple suggestions may be made for the general strategy of the attack.

1 The primary objective should be to discover those facts which are common to many similar situations and can be predicted from factors that are readily observable in each situation. In other words, one seeks scientific laws rather than historical facts.

2 All the important factors should be observed and recorded accurately, so that they can be taken into account in later comparisons and analyses. Good judgment is necessary in determining which are the most important factors. Without such records it is often impossible to tell at a later date just what was tested or observed.

3 Experiments are powerful means of separating coincidences from genuinely causal relationships. There are excellent opportunities to experiment with consumer wants in various markets. Experiments should be designed efficiently and arranged to answer several questions at once. Some of the methods of agricultural experimentation can be utilized with suitable modifications.

4 The restrictions and secrecy which surround commercial research should be relaxed for fundamental studies so that constructive criticism among a large group of research workers can accelerate the progress of these investigations. Contacts between research workers in industry and in the universities should be fostered, and arrangements made for exchanges and visits for training purposes. Under such conditions industry and business will find it easier to attract and hold men of first-rate ability.

5 Resources for social-science research must be increased greatly. Delay in the building up of research centers and training personnel will prove more costly in the end than gradual and progressive development. The potential contributions of social science to our civilization have hardly been tapped.

COMMITTEE ON MEASUREMENT OF OPINIONS, ATTITUDES, AND CONSUMER WANTS

Recognizing the importance of this field of research the National Research Council and Social Science Research Council have established jointly a Committee on the Measurement of Opinions, Attitudes, and Consumer Wants to study problems of measurement and research. It has in process, studies of sampling methods and interviewing procedures, and it is considering other projects that have been proposed. Its reports will be published for the benefit of all who are interested in these problems.

This is a field which should be a meeting ground for engineers and social scientists. Out of it should come both long-run improvements in products and services and aid in the solution of immediate practical problems.

Conference Board Study on College Recruitment

A STUDY on college recruiting by industry made by the National Industrial Conference Board estimates that more than ten thousand new college graduates will be recruited by over a thousand business firms before June, 1948.

According to 142 companies who co-operated with The Conference Board in the study, many companies have been rebuilding their reserves of technical and junior management, and most of the training programs for selected college graduates are in these areas.

The retention rate for college graduates who have had special company training is reported as "extremely favorable." Many companies with ten or more years of experience in college training work state that 75 to 100 per cent of their graduates are still on the job.

The most popular recruitment source, it is found, is the college placement office. Some companies report, however, that they like to work through individual faculty members. Other sources used include employment agencies, advertisements, and professional societies.

A representative of the company's personnel department is usually selected to visit the colleges and carry on the initial recruiting activities. Later, candidates who look good and who are interested may be invited to visit the company and talk with several officers and department heads.

A majority of the companies carrying on these programs prepare attractive illustrated booklets which describe their organizations and the opportunities open in them for ambitious and qualified individuals. These booklets ordinarily are distributed freely to college officials and to applicants, and they serve to supplement the information supplied directly by the company recruiter. In addition, over a third of the companies included in the study employ psychological tests as part of their selection process.

Asked to rate the importance of a list of personal qualities, the companies rated character, intelligence, and personality in that order. Chief reliance was placed on the interview for appraising these qualities. The scholastic record of the candidate was also considered important.

Since 1940, salaries paid trainees have increased about \$100—from approximately \$140 to \$240 a month. Some companies report that they are paying as high as \$300 to \$400 for engineering graduates, chemists, and others with special training. Most companies give automatic or merit increases during the training period, and a majority also grant a raise at the completion of the course.

Two thirds of 60 college placement officers who co-operated in the survey make company visits. "If time and college budgets permitted almost all the others would do so, too." A strong desire on the part of college placement officers for closer relations with industry is indicated.

The placement function is centralized in most colleges today although the older practice of relying on informal contacts between the company and the college faculty still persists. Many company representatives supplement the information obtained at the placement office by direct visits with certain professors or deans.

MECHANICAL ENGINEERING EDUCATION CONFERENCE

ON the invitation of The American Society of Mechanical Engineers, representatives of the Engineers' Council for Professional Development and eight engineering societies serving the general field of mechanical engineering met in New York, N. Y., on March 22, 1948, with representatives of ASME to discuss mechanical-engineering education. The following societies were represented: American Society for Engineering Education, American Society of Heating and Ventilating Engineers, Society of Automotive Engineers, American Society of Refrigerating Engineers, American Society of Agricultural Engineers, Institute of the Aeronautical Sciences, American Society of Tool Engineers, Instrument Society of America, and The American Society of Mechanical Engineers.

ORIGIN OF THE CONFERENCE

The Conference resulted from a similar conference held in March, 1947, which was called to discuss mechanical-engineering education and the desirability of joint student branches at engineering colleges.

The 1947 Conference provided a means of bringing together the mechanical-engineering societies for the discussion of subjects of common interest in the hope that, over a period of time, it would be possible to work toward closer co-operation. It also provided an opportunity for ASME to discharge the responsibility it undertakes to the other mechanical societies in representing the mechanical-engineering curriculum in the accrediting procedures of ECPD.

At the 1947 Conference President O'Brien appointed a committee consisting of David L. Arm (ASEE), Charles H. Colvin (IAS), and Walter L. Fleisher (ASHVE) to determine whether a second conference should be held. This committee recommended the holding of a second conference in 1948, and suggested that a preliminary discussion should be held at the 1947 ASME Annual Meeting at Atlantic City N. J., for the purpose of developing a program. Representatives of industry and the engineering schools took part in the Atlantic City discussion.

MEMBERS OF THE CONFERENCE

E. G. Bailey, president ASME, presided at the 1948 Conference. Present at the Conference were:

B. F. Dodge, member of the ECPD Committee on Engineering Schools, chairman of the Department of Chemical Engineering, Yale University, New Haven, Conn.

C. E. MacQuigg (ASEE), president ASEE, dean of the College of Engineering, The Ohio State University, Columbus, Ohio.

David L. Arm (ASEE), chairman of the 1948 Conference Program Committee, dean, College of Engineering, University of Delaware, Newark, Del.

G. L. Tuve (ASVHE), president ASVHE, head, Department of Mechanical Engineering, Case Institute of Technology, Cleveland, Ohio.

Peter B. Gordon (ASHVE), treasurer, Wolff and Munier Co., New York, N. Y.

Walter L. Fleisher (ASHVE), member 1948 Conference Program Committee, consulting engineer, New York, N. Y.

John A. C. Warner (SAE), secretary SAE, New York, N. Y.

Hollister Moore (SAE), member of staff of SAE, New York, N. Y.

C. L. Babin (ASRE), chairman, New York Section ASRE, Cecil Boling Co., New York, N. Y.

M. C. Turpin (ASRE), secretary ASRE, New York, N. Y.

Arthur W. Turner (ASAE), assistant chief, Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Md.

Charles H. Colvin (IAS), member 1948 Conference Program Committee, New York, N. Y.

I. F. Holland (ASTE), president ASTE, Pratt and Whitney Division, Niles-Bemnet-Pond Co., West Hartford, Conn.

Richard Rimbach (ISA), executive secretary ISA, Pittsburgh, Pa.

C. O. Fairchild (ISA), past-president ISA, consultant, St. Albans, N. Y.

E. G. Bailey (ASME), president ASME, New York, N. Y.

R. L. Goetzenberger (ASME), chairman ASME Board on Education and Professional Status and ASME representative on ECPD, Minneapolis Honeywell Regulator Co., Washington, D. C.

G. R. Cowing (ASME), chairman ASME Education Committee, assistant director, General Motors Institute, Flint Mich.

C. E. Davies, secretary; Ernest Hartford, executive assistant secretary, and George A. Stetson, editor, ASME.

ACCREDITING PROCEDURE OF ECPD

The 1948 Conference opened with a report by Prof. B. F. Dodge on the status of the accrediting of mechanical-engineering curricula. Professor Dodge reported that the ECPD accreditation program, which had been interrupted during the war by the extraordinary conditions prevailing in engineering colleges, was being resumed and the committee was at work on a re-examination of curricula that had been accredited before the war. He explained that a visiting committee, whose members were chosen from the fields represented by the curricula to be examined, rendered its report to the main ECPD Committee on Engineering Schools and that accreditation was a result of action taken by ECPD at its annual meeting, based upon the recommendation of the committee. This procedure placed a heavy responsibility on a single member of the visiting committee. Although all members of the visiting committee were able to form individual judgments on the acceptability of the various curricula under examination at a given college, the mechanical-engineering representative on that visiting committee, for example, bore the heaviest responsibility for the committee's recommendation in respect to that particular curriculum.

The practice of the American Institute of Chemical Engineers, which had set up its own accreditation procedures before ECPD was organized, differed from the general practice of the ECPD, he said. In the AIChE procedure, he explained, reports on individual curricula, based on the Institute's questionnaire and supplemented by the inspector's reports, were sent to members of the Institute's Chemical Engineering Education and Accrediting Committee. This Committee reports to the council of the Institute and their action is reported to ECPD Committee on Engineering Schools who, in turn, report at the next ECPD Annual Meeting. The curricula may then be added to the ECPD list. Professor Dodge saw considerable merit in this procedure and suggested that it be

considered by ASME. The discussion of Professor Dodge's suggestion was focused on the desirability of having ASME set up an accrediting committee to pass on the findings of the inspectors of mechanical-engineering curricula throughout the country. This question was referred to the ASME Education Committee.

SPECIALIZATION IN ENGINEERING EDUCATION

The second phase of the program was a discussion of specialization in engineering curricula and was introduced by David L. Arm.

Dean Arm recalled that at the 1947 Conference it had been generally agreed that the undergraduate program "shall consist of a broad training in the fundamentals of mechanical engineering and that specialization should be properly found in postgraduate training in industry or in the graduate school." The difficulty encountered, he said, was in trying to reach an agreement as to exactly what those fundamentals embraced. He had been bold enough, he continued, to attempt to define "the newly designated bachelor of mechanical engineering" in the following terms:

"He is a man who, we believe, has a rich background in the natural sciences, especially chemistry and physics. He should know how to use that important tool of all engineers—mathematics. He should be well-grounded in his native language and should show competence in its use, both oral and written. He should know something of the history and government of his native land, at least. He should have had a thorough grounding in basic electrical engineering, including direct- and alternating-current circuits and machines and some electronics. We believe that he should have been well trained in the three concurrent stems of mechanical engineering: (*a*) Thermodynamics and heat power, including fluid flow and heat transfer, (*b*) machine design, including engineering drawing, mechanics, and engineering materials, and (*c*) industrial engineering, including economics, accounting, and a study of industrial organizations. Through our training, we believe that we should have instilled in him habits of neat and orderly methods of assembling and presenting all kinds of data. He should have learned to adapt himself to new situations and to get along well with people. Finally, and most important, we humbly hope that we have taught him to think!"

DISCUSSION OF DEAN ARM'S SPECIFICATION

In the discussion which followed and in which everyone present took part, there was general agreement with Dean Arm's "specification," although representatives of a few of the societies devoted to certain areas of specialization themselves were inclined to feel that, for engineers preparing to enter the industries in those fields, some degree of specialization was desirable in undergraduate curricula. In general, those who spoke in favor of specialization were equally insistent on the value of fundamentals and recognized the difficulty of specialization in the usual four-year curricula. This led to the support of five-year curricula by some persons and to the suggestion that examples from specialized fields could be brought into fundamental courses. Proponents of "fundamentals" also found difficulty in fitting these subjects, and others in the field of humanities, into the four-year curriculum; suggested elimination of the traditional distinctions, civil, mechanical, electrical; and called for more mathematics, and for differentiation between engineering and industrial areas of education. There was general agreement of the need for developing resourcefulness, imagination, loyalty, and leadership, and the need for closer co-operation between industry and educational institutions.

In summing up his views of the discussion, C. E. MacQuigg stated that he was in general agreement with what had been said and proposed a five-year curriculum in which the first three years would be spent in fundamentals such as mathematics, physics, chemistry, and English, followed by a year devoted to nonengineering studies, e.g., history, economics, sociology, and the like, and a fifth year spent in some major department of engineering studies. At the end of these five years the student would be called "an engineering graduate."

CAN ENGINEERING SOCIETIES HELP?

The third phase of the discussion was also introduced by Dean Arm. It revolved around the question, "Can the societies aid in imparting to the undergraduate student a better understanding of the professional obligations of the engineer?"

Dean Arm quoted Dean C. J. Freund, of the University of Detroit, as saying: "I am inclined to believe that a very great need exists for imparting to undergraduates a much clearer understanding of the obligations and responsibilities of professional status, code of ethics, employment relations and opportunities, state-board registration, traditions and ideals of the professions, organization and function of engineering societies, and much else within the general area."

Continuing his comments on the question, Dean Arm said:

"It seems to me that here is one of the areas in which the societies can be of greatest help to engineering education. Although those of us who teach are continually stressing the professional aspects of our training, we need much assistance in trying to develop a professional consciousness in our students. The inportant task is in the building of an esprit de corps, and in this task we must utilize all of the resources of the parent society, the local sections, and the student branches. The societies have made some contributions, but greater efforts must be exerted.

"Some of the local sections have instituted programs of co-operation with near-by student branches which are proving to be effective. Individual members of these sections are taking part in the student programs, either as speakers at meetings or assisting in individual guidance and counseling of the undergraduate members. Joint meetings of the local sections and the student branches are held. These measures are effective, but not enough of these programs are in effect at present.

"One means of assisting the colleges in this task can be accomplished rather easily. The Education Committee of the society should attempt to secure speakers for the student-branch meetings who are not only technically capable, but who are inspirational speakers as well. Every effort should be made to discover and make available those men who possess a strong sense of professional responsibility. Such people can do much to supplement and emphasize our efforts.

"A third suggestion has to do with the teaching of the history of the profession to our students. Few engineering colleges have instituted such courses because of a lack of good text material and because members of the usual history departments are not well qualified in this subject. Would it not be possible for the national societies, perhaps through the ECPD, to survey this situation? Perhaps some means could be found to subsidize the writing of such a history and the training of engineering historians to teach such courses. It is my belief that, before one can be cognizant of the professional aspects of his training, he must know something about the development of the profession."

In the discussion which followed there was general agreement that the engineering societies could be of great assistance to the colleges by providing speakers and advisers and that similar annual conferences should be held in the future. G. A. S.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Education and Training

EDUCATION and practical training of mechanical engineers in the United States was the subject chosen by R. E. Doherty, Fellow ASME, president, Carnegie Institute of Technology, for one of the centenary lectures given at the one hundredth anniversary celebration of The Institution of Mechanical Engineers. The paper appears in The Institution of Mechanical Engineers Proceedings, Vol. 157, 1947 (War Emergency Issue No. 31), and also in *The Journal of Engineering Education*, December, 1947.

Dr. Doherty pointed out that present status and trends in education may be understood better if two points are compared—say twenty-five years ago and now—and then examine carefully the slope at the second point.

In comparing the present four-year curriculum with that of 25 years ago, a reduction in the over-all requirements is found. As to the components, one finds no change in mathematics, a small increase in science, but a reduction in engineering subjects to make room both for an increase in humanistic-social subjects and for the general reduction. Despite the former, the foreign-language requirement was reduced. The amount of shopwork in the curriculum was decreased.

In 1923 industrial management had become a recognized area in the field of mechanical engineering. By then seventeen engineering schools—roughly 12 per cent of the total—had established special curricula in this area. The trend continued during the next twenty-five years, so that now twenty-nine schools have such curricula accredited by the Engineers' Council for Professional Development.

There has also been a trend toward a multiplicity of specialized curricula and courses. The advances of science and the tremendous increase in the scope of its industrial applications have of course brought newly defined specialized industrial fields. These changes have been reflected both in the organization of the profession and in education. Mechanical engineering has not escaped. For example, in the profession there are separate organizations in the following fields: heating and ventilating, automotive, aeronautical, refrigeration, agricultural. In education, these and other related fields are represented in special curricula. And the number of specialized individual courses is almost beyond count.

Another significant change has been the great increase in graduate work. In the early 1920's, fewer than 100 advanced degrees were conferred annually in *all* branches of engineering, and practically all of these were the master's degree. In 1940 there were 1329 masters', 108 doctors' degrees, of which 170 masters' and 7 doctors' were in mechanical engineering. In 1946 there were 1036 masters' degrees and 82 doctors', of which 178 masters' and 10 doctors' were in mechanical engineering.

Professional influence has of course also been felt. The Society for Promotion of Engineering Education (now the American Society for Engineering Education) has been most influential in bringing about a clear formulation of purpose and in encouraging engineering teachers to adopt it, as indicated later. One of the primary functions of the ECPD is to accredit curricula in engineering. In the 1920's there were some 150 colleges offering curricula in engineering. In spite of the great increase in students, the number of such colleges has not increased, and only 133 of them have accredited curricula. Another result is the definite restraint by this Council upon the continued multiplication of specialized curricula. The ASME has also been influential by bringing practicing engineers and college teachers together in conference. State laws require that practicing engineers be registered.

There has been a growing tendency, especially in view of experience in training technical personnel during the late war, to recognize the important role which technical institutes should play in the whole scheme of technological education. In order to assure a better balance between the roles of the engineering college and the technical institute, the ECPD has now undertaken the accrediting of these institutes. Also, an increasing number of junior colleges have offered elementary courses in engineering.

Another strong trend has been the increasing percentage of practicing mechanical engineers who are college graduates. It is estimated that 80 per cent of the present membership and 97 per cent of the new members of ASME are graduates.

In 1922 there were 56,649 enrolled in engineering colleges; in 1940, the last prewar year, 110,618, of whom 28,600 were in mechanical engineering; and in 1946, an abnormal year, more than 200,000, of whom some 43,000 were in mechanical engineering. Large numbers are temporarily appropriate, in order to offset the deficit of new engineers caused by the war.

In examining the slope of the second point, Dr. Doherty said that great changes are now getting under way in all branches of formal engineering education. These are aimed at placing greater emphasis upon fundamentals that lie at the center of scientific and engineering knowledge, and less upon the specialized information and "know-how" that lie at the periphery; and at recognizing social and civic responsibilities, and preparing the student for them and thus for a worthy personal and professional life. The velocity of change is as yet low, but the acceleration is high.

The new philosophy of engineering education and the formulation of definite objectives were stated in 1940 by the SPEE and endorsed by the ECPD. The objectives were reviewed and reaffirmed by both organizations in 1944. Although the new outlook had become focused in the earlier report, the recommendations were at first received by engineering faculties with only mild enthusiasm. The war, however, had its impact on educational thinking and brought a more

general acceptance of the new outlook. Thus with this added impetus and the sponsorship of these two professional bodies, in both of which mechanical engineers are represented, this new movement is under debate in every engineering faculty. Many of them have reached the stage of definite planning and new programs are in effect at some institutions.

The central recommendations of the second SPEE Report, looking to the implementation of the new purpose, are that "the attempt to make the undergraduate student proficient in specialized subdivisions of engineering practice must be abandoned in the interest of developing mastery of basic principles;" there be greater emphasis upon cultivation of creative ability; the utmost care be exercised in the selection and development of engineering faculties; graduate work of high quality be expanded; instruction and research be developed as complementary and co-ordinate functions; production management be included as a phase of engineering activity; the great importance of the role of technical institutes in the scheme of technological education be recognized; in the division of the student's educational time, not less than 20 per cent be devoted to the humanistic-social studies; these studies be planned so as to constitute "a unified, developing sequence extending through the curriculum."

These recommendations created problems. The four-year curriculum is already crowded and without room enough even for scientific and technological subjects. How then could the humanistic-social content be practically doubled? There are two schools of thought. One would lengthen the undergraduate curriculum to five years. The other would cut down specialized courses to make room, and let the student specialize on the job after graduation, or continue for one, two, or three years in graduate work. Four institutions have recently adopted the five-year curriculum—Cornell, Ohio State, Minnesota, Louisville. A few have followed the other course. The rest are struggling with the problem.

Another is the related long-run versus short-run issue Should education prepare the engineering student for continuing professional growth or for immediate proficiency in engineering routines? In other words, should more of his time be devoted to a mastery of fundamentals and less to specialized study, or the other way around? The SPEE reports, endorsed by ECPD, are clear on this point—prepare for the long pull. But the pressure from small industries is opposite. Most of the large manufacturing industries, however, favor the SPEE proposal.

Still another critical problem is the shortage of qualified teachers, and this problem is now aggravated, and others created, by the overwhelming student enrollments. Thus engineering educators in the United States have their hands full.

With regard to practical training of mechanical engineers, the following question was answered by ten manufacturing companies: How does the college graduate who comes to the company acquire the practical training and experience necessary to become a mechanical engineer?

The replies indicate, in general, that the college graduate must serve an "internship" to acquire the necessary practical training. Most of them have definitely scheduled programs, and some have highly developed plans involving classwork paralleling the shop or drafting-room experience. Certainly the trend in large industry is toward a planned program.

Another method is the "co-operative" plan between college and industry in which the student spends alternate periods on the campus and in the plant. This plan is on the increase. In 1925 there were sixteen such plans; in 1941, there were thirty-three.

Surplus Machine-Tool Status

THE present status of war-surplus machine tools is reviewed by William E. Bullock in an Engineering Societies National News Letter, March, 1948. It is revealed that by June 30, 1948, the War Assets Administration expects to have virtually completed the disposal of surplus machine tools declared to it by owning agencies. This will culminate a three-year program during the operation of which about $1 billion worth of such tools have been directed into peacetime use, put into civilian hands, donated to schools and institutions for training purposes, placed in local government agencies, or set aside in a national machine-tool reserve.

An estimated $300,000,000 worth remains to be cleared off WAA inventory in the next four months. Indications are that most of these tools will be added to the national stock pile.

The anticipated stalemate in the machine-tool industry has not only failed to materialize but it is also no longer a threat. Actually, there is today a live demand for machine tools which cannot be met from WAA stocks left. At the other end of the line, the scrap industry, faced with critical shortages, can no longer hope for such relief from WAA stocks as was anticipated when the war ended, and so is forced to look for scrap elsewhere.

WAA at the present time is making offerings of tools and equipment in the following sequence: First, to the national stock pile for future emergencies; second, to government agencies; third, to priority groups and nonpriorities. The offerings are all made by individual items. After going through this sequence, any residuals are being offered in lots instead of items. These offerings of lots may help to fill the present critical demand for scrap material if the tools are not wanted for rebuilding or use.

Regarding the national machine-tool reserve (Janmat program), the present preferred disposal category, this country has always found itself to be inadequately prepared to start producing materials for defense at the beginning of emergencies. Our machine tools have never been of sufficient quantity. It has always been necessary to build new tools before special defense materials could be started flowing in sufficient quantity to meet the emergency.

After the successful conclusion of World War II it was decided, and rightly so, that next time there might be no time, and a strategic reserve of machine tools and equipment should be established to meet instantly the initial phase of any emergency—and perhaps even help stave it off. In order to facilitate this policy, Public Law 364, passed August 5, 1947, required the Services to acquire machine tools and equipment for maintenance of military installations and of the strategic reserve.

The Services then certified to WAA that they would require approximately 92,000 units. Recently this figure has been increased to approximately 182,000 items, practically double the original figure. This new figure is still only a minimum quantity necessary in case of a national emergency.

Regarding tools for educational uses, the need for supplying machine tools and equipment for fitting out the shops of nonprofit educational institutions has been well met by WAA. The institutions should now be able to train machinists and other specialists adequately, for they have secured much fine equipment. The nominal-price program gave the schools opportunities to fill their requirements which would never have been possible were they required to purchase at market levels. Similiarly, to assist State and local governments, a donation program was inaugurated. Under this program, these bodies have been able to acquire much-needed equipment for which they had not been able to get appropriations.

For the ending of the WAA machine-tool and equipment

disposal program, the offering of material by lots started in substantial volume in March of this year, and it will undoubtedly be by this method that the largest quantities will be disposed of, possibly to be stripped of motors and controls and melted down for their metal contents.

Dynamic Testing Machine

THE Établissements A. J. Amsler & Cie., in co-operation with the Établissements R. & H. Huber ("Pallas" tires), have developed a machine for testing the toughness and the static and dynamic strength of rubber and fabric strips, and other materials used in tire manufacture. A description of the machine, which appeared originally in *Le Génie Civil* (France), Sept. 15, 1947, is given in *The Engineers' Digest* (British edition), February, 1948.

The machine is designed to enable measurements to be taken at normal temperatures and at the higher temperatures reached by tires as a result of heat due to friction. The test pieces can be subjected to static and alternating loads with or without prestressing. The machine measures elastic and permanent deformations and records the number of cycles to which the test piece has been subjected.

Referring to Fig. 1, the alternating load is supplied by a torsional exciter consisting of a vertical arm *A* oscillating without friction about a horizontal hollow shaft *B* containing a torsionally elastic bar *C* attached at one end to the arm *A* and at the other to the frame *D* of the machine. The exciter vibrates owing to the unbalance of a rotating disk *E* which is situated on arm *A* at about one quarter of its length from the lower end. The unbalance of the disk can be adjusted by angular displacement of the two equal out-of-balance masses *F* and *G* on a circumference with the same center as the disk. The disk is connected by a light flexible belt drive *I* to a synchronous motor rotating at 1000 rpm.

The test piece, which is either 80 or 40 cm, is attached to the upper end *K* of arm *A*. The two parts *L* and *L'* of the test piece are subjected to an alternating load provided the static loads at their outer ends are at least equal to one half of the pulsating load supplied by the exciter. The static loads are provided by (1) the weights *M* and *M'* attached to the steel bands *O* and *O'*; (2) the carriages *P* and *P'* which are fixed on the steel bands and which can move horizontally along the frame of the machine; and (3) the attachments *Q* and *Q'*. The carriages move slightly during each load cycle, owing to the deformation of the test piece, but can be regarded as stationary in the vibrating system because of their comparatively great inertia.

To avoid shock effects during the rupture of one of the two

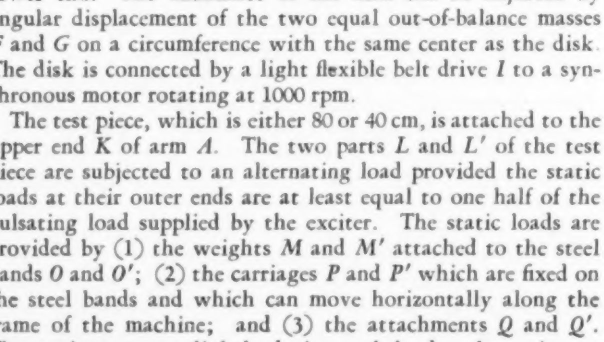


FIG. 1 AMSLER MACHINE FOR DYNAMIC TESTING OF RUBBER AND FABRIC STRIPS

parts of the test piece, the weights *M* and *M'* are supported by rods *R* and *R'* provided with damping pistons *S* and *S'* moving within the oil-filled cylinders *T* and *T'*, so that the weights can come to rest slowly on their supports *U* and *U'*. The system *M*, *M'*, *R*, *R'*, and *S*, *S'* is balanced by means of counterweights *V* and *V'*.

The masses *M* and *M'* consist of a number of cylindrical elements enabling the static load to be varied by 100 grams (0.22 lb) at a time up to a maximum load of 10 kg (22 lb). The maximum (half total) amplitude of the deformation is 15 mm (0.59 in.) and the pulsating force can be varied from 0.1 to 2.0 kg (0.22 to 4.4 lb); the exciting frequency is 1000 cpm, a 100-watt motor being used to actuate the system. Tests made with a cotton cord of type 23/5 under a static load of 3.8 kg (8.4 lb) and a superimposed alternating load of 2 kg (4.4 lb), that is, with a resultant fluctuating load of 1.8 to 5.8 kg (3.98 to 12.79 lb) produce rupture after 22,000 reversals.

The alternating load can be varied by altering the angle between the two masses *F* and *G*. The static or dynamic deformations of the two parts of the test piece are recorded on paper by means of recording pens *a* and *b* mounted respectively on carriages *P* and *P'*, the recording strip being on a drum which is driven by a synchronous motor through a gear train displacing the paper at speeds of 10 or 5 mm per min, so that 1-mm displacement will correspond to either 1000 or 2000 reversals. The oscillating arm *A* also carries a stylus *d* which records the amplitude of the vibrations. The total number of reversals can be read from the curves or recorded by a revolution counter with a synchronous motor. For tests at higher temperatures, each of the two parts of the test piece is placed in a resistance-type electric oven, 20 cm in length; the temperature is controlled by a slider resistance and can reach 120 C (248 F). The machine can also be used to determine the behavior of bonded and vulcanized materials.

Mobile Gas-Turbine Plant

A LONG-STANDING need of power utilities and industry using power for a compact, easily-moved, short-notice source of emergency electric current may be filled within the next few years by mobile gas-turbine plants now under development by Allis-Chalmers engineers.

Studies have already been made of 3000- and 6000-kw units to be mounted on railway trucks for rapid movement over normal railway track or comparatively irregular freight and utility yard tracks, it is reported. The proposed units could operate as a sole source of power or could be synchronized with an existing power system.

Simplicity, extremely smooth operation, and no requirement for water would characterize the gas-turbine plants, according to engineers. Operating on oil, the units would require only fuel-line connections to tank cars or storage tanks, in addition to the electric transmission-line connection.

The prime mover of the 3000-kw unit operates on the simple gas-turbine cycle with regenerator. With an inlet temperature of 1300 F, the unit would have a fuel-bus efficiency of about 23 per cent at full load. Mounted on eight carrying axles arranged in four standard freight-car trucks, the power plant would weigh approximately 230,000 lb. Sufficient oil-tank space is built into the unit to permit full-load operation for at least six hours.

The turbine unit is coupled to a 3600-rpm generator through a reduction gear. All working air for the gas-turbine plant and cooling air for the generator is taken in through filters in the side walls of the cab. All electrical equipment and synchronizing apparatus is built into the cab.

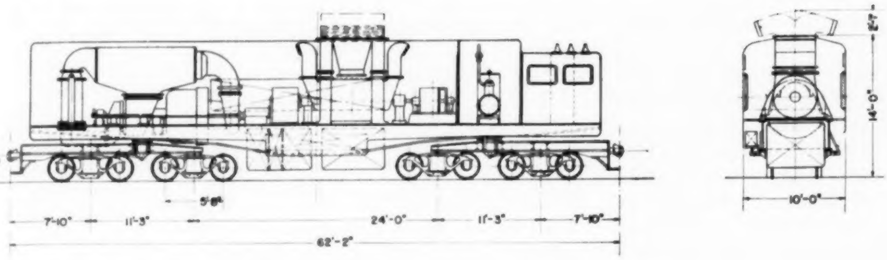


FIG. 2 3000-KW MOBILE GAS-TURBINE POWER PLANT

General arrangement of the more powerful 6000-kw 3600-rpm unit is identical to the smaller power plant, except that the inlet temperature is 1150 F, and a gear will not be necessary. Efficiency will be approximately 21 per cent. Total weight would be about 500,000 lb with tanks loaded for eight hours' operation and the unit ready for service. If a higher-efficiency unit with limited life is desirable, the 6000-kw-size gas turbine can be built for 1300 F gas-inlet temperature, in which case the efficiency would be 23 per cent and the generator output would be increased to 7500 kw.

Standard draft gear and air brakes would permit these power plants to be moved in freight trains. The regenerator and the air-exhaust stacks for generator and regenerator must be removed for standard clearance.

The mobile gas-turbine plants, it is said, appear to be a promising source of extra power which can be made available within a few hours. Where regular power plants are out of operation when disaster strikes, such units could be located on a rail siding from where they could quickly deliver power into the existing system. Similarly, industrial plants faced with a sudden temporary need for extra power could put a mobile power plant into operation, to avoid the expense and time involved in the construction of a powerhouse. It could also provide emergency service during service shutdowns or turbine failure.

An abstract of a paper entitled, "Gas-Turbine Railway Vehicles," presented by W. Giger, Allis-Chalmers Manufacturing Company, at the 1947 ASME Annual Meeting, also appears in this issue on page 457.

Synthetic Detergents

PRODUCTION of synthetic detergents, the "soapless soaps," will soon reach 750 million pounds annually, and predictions of a three-billion-pound production within fifteen years have been made, an article in the January, 1948, issue of the ***Industrial Bulletin*** of Arthur D. Little, Inc., reveals. It is pointed out that although the synthetics, backed by the soap industry's inimitable promotional vigor, are doing well in competition with soap for ordinary cleaning, the producers are sparing no efforts to find new uses where soap is not applicable. One or another of the synthetics can be used in water which may be cold, hot, hard, salt, acid, or alkaline, and can usually be rinsed off easily and completely. Because of these and other special properties, many possibilities appear for synthetics, not only in cleaning, but in the proper control of wetting and mixing.

In the cold rolling of steel, an oil emulsion is applied to the surface of the steel sheet. With a synthetic detergent this emulsion still further reduces the friction and makes it possible to increase the speed at which the mill operates. Experimental studies indicate a possible increase in capacity of approximately 10 to 15 per cent, and large-scale adoption of the procedure is expected. In acid-pickling of steel, detergents added to the pickling solution remove oil films and carbon from steel surfaces, permitting more intimate contact with the acid; as corrosion inhibitors, they protect the metal from excess acid attack. One detergent forms a foam on top of the pickling bath, which in experiments has partially blanketed evolution of acid fumes to make the surroundings more agreeable.

Accumulation of coal dust in the air of mines has long presented a health hazard. A few mines spray a fine mist of detergent solution into the atmosphere of the mine to dampen and ground suspended particles. Synthetics as wetting agents are sold for fighting fires, particularly in goods such as baled cotton or waste paper.

Concrete with air entrapped in minute air pockets is more resistant than the older types to cracking and scaling caused by weather and salts for dissolving ice. Some detergents are efficient as air-entraining agents in concrete, and although they may never completely replace existing products in this field, the market is large. At least one state-highway construction program will use them.

Streets may be as clean as the vehicles which traverse them, if methods tested in two large cities are applied. As little as five pounds of detergent in the street-cleaning water was sufficient to wash a mile of highway. The detergent removed all oil film from the street in one flushing operation, leaving a skid-free surface. Cleaning of automobiles, buses, and trucks is now well-established, with several proprietary compounds on the market. Advantages over alkaline washing materials include superior cleaning and easier rinsing, with less attack on the automobile finish. Regular washing with detergent solution keeps the car free from dust and oil film, and permits a high polish.

In the preparation of food, synthetics have had wide use. With lye solutions, they help to peel fruit prior to canning. Household detergents in small concentrations remove adhering insects and grit efficiently from vegetables such as spinach and greens, and are easily rinsed away, leaving no taste on the vegetable, in contrast with soap. At least one detergent has been employed in commercial cake mixes to produce a light fluffy product.

Crash Injury Research

IN 1942 when the Crash Injury Research Project was started, there was a widespread belief that 2-in. "2000-lb" safety belts would cut people in two. One of the early objectives of the project was to track down reported cases of this nature. Details of many cases were studied and, as no such cutting of the body was found, these rumors are now considered to be baseless.

In addition, there was a widely held conviction that safety belts caused internal injuries in severe accidents; consequently many pilots unbuckled their safety belts in crash emergencies thinking they would avoid the danger of internal injury from this cause. Another objective of Crash Injury Research was therefore to verify the nature and location of supposed injuries from safety belts so that belts could be improved in design to lessen the chances of injury. If belt injuries were found, it was proposed that the design of installations could be modified

by increasing the width of webbings, by changing positions of anchorages, and by providing a yield point or stretch under abrupt heavy loads.

A recently reported analysis of crash injuries showed that among 102 survivors whose safety belts failed, only two showed any evidence of internal abdominal injury. The fact that many persons weighing as little as 115 to 130 lb had broken 2000-lb safety-belt installations without visceral injuries raised serious questions as to whether (1) safety-belt failures were caused by tearing of the webbing at the edges where pinched by the jack-knifing action of the body; and (2) belt failures were occurring at far less than designed loads.

In order to find out whether people actually were tolerating 2000 lb of snubbing action in breaking 2000-lb belts without injury, the Crash Injury Research Project collected 80 safety belts of various types from airplane manufacturers, aircraft-accessory manufacturers, and airlines, and submitted them to the Naval Medical Research Institute. NMRI had agreed to undertake tests of the belts under "dynamic and functional conditions" simulating those of a crash, in order to determine the forces to which people were being subjected in breaking 2000-lb safety belts. In order to test the belts functionally, a research group at NMRI designed a 25-ft tower with a sliding carriage to which the safety belts could be attached. A 200-lb folding dummy was developed which would simulate the jack-knifing action of the body over safety belts. Dropping the carriage with the belts and dummy against an air spring at the bottom of the tower enabled the investigators to develop desired velocities and controllable rates of change of velocity whereby the dummy could be thrown against the belt and doubled over it to simulate the folding tearing action of the body in a crash. Gages placed between the belts and anchorages recorded the strains on the belts when failures occurred.

The strength of 2-in. 2000-lb safety belts, as tested at NMRI, was unexpectedly high. Despite the tearing strains imposed on the edges of the belts by the folding dummy, only three belts showed a holding capacity of less than 2000 lb; 45 withstood breaking strains exceeding 1250 lb, with indicated holding capacities of more than 2500 lb. In ten cases the end attachments broke before the webbing.

These NMRI tests indicate that conventional 2-in. safety belts with a designed holding capacity of 2000 lb, if properly installed in aircraft, actually give a snubbing action at the hips that exceeds 2000 lb. Linking the results of these tests with accident data shows that instead of causing injury in the abdominal region, the heavy snubbing action of safety belts actually provides a surprisingly high degree of protection to the body between the chest and knees by holding the hips and preventing rapid movement of the central portions of the body toward dangerous objects.

Because of the extreme danger of head injury, and frequent failure of safety belts, members of the Crash Injury Research Project feel that the amount of future crash protection that can be provided by stronger safety belts and safer cabin structures can be judged at this time only from occasional cases where the belt holds and the head, by chance, misses dangerous objects. These cases of noninjury are very significant, for the implication is that if more belts hold and more heads miss dangerous objects, safety in future aircraft accidents can be amazingly increased.

Toward this end the Crash Injury Research Project has recommended stronger safety belts since its first report in 1943. An increase in tensile strength of safety belts is imminent, but no corresponding increase in the strength of anchorages will be required. New safety belts having the proposed tensile strength of 3000 lb will therefore meet Civil Air Requirements when attached to anchorages with a required strength of only 850 lb, but unless the manufacturers see the need and value of stronger anchorages, the increased holding capacity of the proposed belts will be virtually nullified and safety-belt installations will continue to fail in survivable accidents.

Ozone Measurement

IT is well known that the variation in the total amount of ozone in the stratosphere has a direct correlation with latitude and season, and that different types of air masses show variations in ozone content which are associated with their origin or movement. However, it is not known at present whether any direct relationship exists between such ozone variations and current weather conditions. The development of a suitable technique for routine measurement of total ozone is of great interest in order to establish possible correlations between ozone concentrations and weather phenomena. If such correlations do exist, ozone data may become very useful in weather forecasting.

At the request of the Naval Research Laboratory, the National Bureau of Standards recently made total-ozone measurements of the stratosphere over the Organ Mountains in New Mexico by means of ground-based equipment employing a photocell and selected filters. This method serves as a check upon ozone determinations by V-2 rocket flights from White Sands Proving Ground. The technique developed by the Bureau makes use of phototubes sensitive to ultraviolet radiation of wave lengths under 3400 A and filters with transmittances beginning at 2900 to 3100 A and increasing with wave length. Since ozone is strongly absorbing within this region, the spectral energy distribution of sunlight reaching the earth's surface is greatly affected by its presence. Hence when the transmittances of the filters are measured for sunlight (using the phototube as a detector), the observed value depends upon the solar energy distribution, and therefore is a function of the amount of ozone within the beam of sunlight under study.

The spectral energy curve of sunlight outside the earth's atmosphere may be calculated from measurements of filter transmittances of sunlight (for various altitudes of the sun) after correction has been made for Rayleigh scattering at the altitude and location of the observing station. Knowledge of the spectral response curve of the phototube, the spectral transmittances of the filters, and the spectral transmittances of selected amounts of ozone is required for this computation. When the spectral energy distribution of solar radiation outside the earth's atmosphere has been determined (within the spectral region extending from about 3000 to 3400 A) by this method, or has been obtained from data of other observers, the total amount of ozone in the stratosphere may be derived as a function of the observed filter transmittance of a single filter. After this relationship has been established, the total amount of ozone may be quickly determined from one filter transmittance measurement.

In the investigation at San Augustine Pass in the Organ Mountains, two phototubes and four filters were employed, providing eight independent determinations of the ozone value for the period of June 29 to July 4, 1947. The extremes of these eight determinations were about 0.19 and 0.24 cm of ozone at normal temperature and pressure (that is, if all the ozone in the stratosphere were brought to sea level and reduced to 0 C, the total thickness would be 0.19 to 0.24 cm). During this period the mean value was observed for continental tropical air, the higher value for a polar air mass, and finally the lower value for a tropical maritime air mass. The weighted mean of all determinations was 0.21 cm.

Additional measurements during the week of December 15, 1947, should give a winter value for total stratosphere ozone at the same location (report to be published after analysis of data). These measurements will provide an independent set of ozone data for the time of the year when the sun is near its maximum declination south, while the midsummer determinations furnish data corresponding approximately to the maximum northern declination of the sun. Positive conclusions of the ozone-weather relationship can be made only after more comprehensive data have been obtained and analyzed from many different observing stations. It is understood that such a project is being planned by the Weather Bureau.

Safety

THE principal hazards to safety in the home, and the means for eliminating or reducing them are discussed in detail in a new 200-page edition of "Safety for the Household," now available from the Government Printing Office as National Bureau of Standards Circular 463. While written mainly for the average present-day household, this booklet provides information that is also of value in the construction and safe operation of schools, hotels, hospitals, stores, warehouses, and industrial plants.

Chapters on gas, building construction, refrigerants, fire prevention, heating equipment, plumbing, fire extinguishers, electrical equipment, and other special items have been prepared by qualified specialists from the various sections of the Bureau dealing with these particular subjects. The chapter on suggestions for building a home and the discussions of hazards in the use of hand tools and machinery will be found especially helpful. In recent years new trends in home design, new household equipment, and modern toys have brought new sources of accidents. In an effort to keep pace with the hazards introduced by these developments, sections on such topics as television and miniature gasoline engines have been included.

NBS Circular 463 may be obtained only from the Superintendent of Documents, Washington 25, D. C., at a cost of 75 cents per copy.

Nuclear Science Laboratory

A $250,000 grant for atomic research and training of nuclear scientists has been made to the Massachusetts Institute of Technology by The Texas Company, according to a recent announcement by Dr. Karl T. Compton, member ASME, president of the Institute, and Col. Harry T. Klein, president of The Texas Company.

The funds will be used for long-range pure research in nuclear fission and related basic studies on the ultimate nature of matter and energy, to construct high-voltage equipment of advanced design, and to train scientists in nuclear theory and its application.

This work will be carried on primarily in the Laboratory for Nuclear Science and Engineering, which will co-ordinate its efforts with the departments of physics, chemistry, chemical, electrical and mechanical engineering, metallurgy, and biology, for maximum interchange of information.

Investigations already under way in the laboratory have revealed that cosmic rays, nature's source of particles of highest energy, are composed of less than one per cent free electrons, contrary to former scientific belief. The newly acquired knowledge that cosmic rays are principally protons is another fact in the unexplored field of nucleonics which may lead to vast practical applications.

In another direction, new hope for sufferers from certain diseases is offered by experiments in physical medicine that employ extremely high-voltage short-wave x rays.

The tools of science which will be used in this project include the Institute's cyclotron and two electrostatic generators with capacities up to four million volts which are already in operation. Future developments call for still larger instruments, including a 300-million electron-volt synchrotron, now in the process of construction, and a 12-million volt electrostatic generator.

One division of the investigation will concentrate on studies of nuclear theory, nuclear chemistry, and other problems bearing on a better understanding of nuclear structures and forces, and of the fission process and its products.

One important phase of the program is the training of competent nuclear scientists and engineers by allowing them to conduct pioneer studies and thus gain invaluable firsthand experience. As future teachers and industrial researchers, the information and techniques they acquire on the project will contribute substantially to scientific knowledge in schools and industry.

Russian Steam Turbines

AN All-Union Conference on Steam Turbine Techniques was held at Leningrad, USSR, in March, 1947, and is reported briefly in *The Engineers' Digest* (British edition), February, 1948. Reference was made to the 100,000-kw steam turbine running at 3000 rpm with initial steam conditions of 90 atm (1320 psi) at 480 C (895 F) built by the Leningrad Works "Stalin." Future work includes the development of topping turbines for steam conditions of 175 atm (2570 psi) and 550–600 C (1020–1110 F). The Economizer Works are reported to be engaged on the design of high-pressure turbines for centrifugal boiler feeders with initial steam conditions of 90 atm (1320 psi) at 480 C (895 F) and a back pressure of 1.2–2.5 atm (17.6–36.8 psi). Turbine capacity is 1350 kw and its efficiency at the coupling is 70 per cent.

The report also states that at the Central Boiler and Turbine Institute a new aerodynamic test plant equipped with optical instruments of the Toepler type was installed. A large aerodynamic wind-tunnel plant is being erected at that institute which will include an air compressor capable of delivering 30,000 cu m (1,059,000 cu ft) of air per hr at 7 atm (103 psi) pressure. Methods for the computation of turbine-blade profiles are being developed and investigations into erosion and corrosion in the last turbine stages are being made.

At the same institute important work on gas turbines is in progress and the characteristics of both open-cycle and closed-cycle types have been studied. A single-stage axial compressor was installed in 1946 and a first series of tests was run. Experiments aiming at the development of a three-stage axial compressor are under way and an experimental single-stage gas turbine is being built. At the laboratory of the institute the fatigue strength and the creep properties of turbine materials at 800 C (1470 F) are also being investigated.

The preliminary layouts of two mercury-steam plants were completed in 1946. The first of these projects is a 4000-kw mercury turbine to form part of a 10,000-kw mercury-steam plant. This is to be installed at the Central Boiler and Turbine Institute. Mercury vapor will be generated at 10 atm (147 psi) and 515 C (960 F) and the over-all plant efficiency is estimated at 40 per cent. The second mercury-steam plant is intended for the driving of blast-furnace blowers, and the exhaust mercury vapor is to be used for heating the blast.

The original article on which the foregoing is based appeared in *Kotloturbostroenie*, Russia, No. 3, 1947.

Magnetic Fluid Clutch

A NEW type of electromagnetic fluid clutch, said to have extensive applications and many unique features, has been developed at the National Bureau of Standards by Jacob Rabinow. The development of this clutch, which is based on Rabinow's discovery that frictional forces between solid surfaces and certain types of fluid media can be controlled by application of magnetic fields, was part of the work on the mechanical aspects of the high-speed electronic digital computers being built at the Bureau for the Office of the Chief of Ordnance, Department of the Army. Characterized by ease of control, high efficiency, smooth operation, long life, and simplicity of construction, the new magnetic fluid clutch is reported to be particularly suitable to applications in servomechanisms, automatic machinery, automotive service, and many other fields where ease of control and constancy of characteristics are important. All patent rights for the clutch have been assigned to the U. S. Government.

The magnetic fluid clutch operates on the following basic principle: When the space between two parallel magnetic surfaces is filled with finely divided magnetic particles and a magnetic field is established between the two plates, the magnetic particles bind the plates together against movement parallel to their surfaces. The magnetic particles may be finely divided iron which, for most applications, is mixed with a liquid such as oil, to prevent packing and to afford smoother operation of the clutch. When a portion of this mixture is acted on by a magnetic field, the iron particles are mutually attracted, bind together in the field, and the mixture seemingly "solidifies." As the magnetic field can be produced by an electric current, a simple means is thus obtained for the control of the binding force over a wide range.

Preliminary results at the Bureau indicate that the electromagnetic fluid clutch has numerous advantages over many other existing types. It is characterized by extreme smoothness of action because all contacting surfaces, both of the plates and of the iron powder, are coated by a lubricant. The clutch is easy to control and requires small amounts of electric power. The control is extremely smooth from the minimum which is determined by the viscous drag of the oil, to the maximum

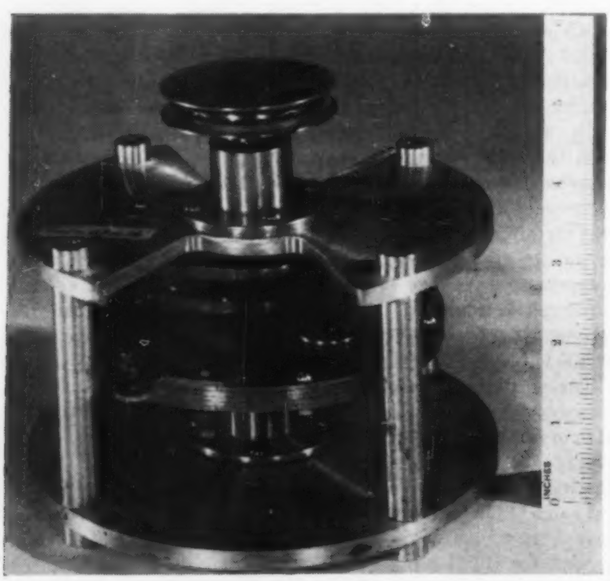


FIG. 3 FIRST NBS TEST MODEL OF PRACTICAL MAGNETIC FLUID CLUTCH

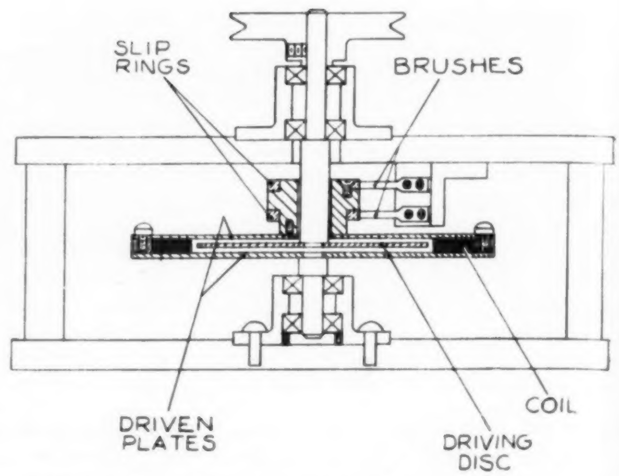


FIG. 4 CROSS SECTION OF FIRST TEST MODEL OF MAGNETIC FLUID CLUTCH

which is controlled by the magnetic saturation of the iron. Unlike other electromagnetic clutches which follow a square law, wherein the torque is proportional to the square of the electric current, torque in the new clutch is proportional to the control current over a wide range of torque values. Hence the clutch is particularly suitable to servomechanism applications where linearity and good control down to zero current are of primary importance.

Another unusual and desirable feature found in some forms of the magnetic fluid clutch is that the value of static friction does not differ appreciably from the value of kinetic friction; hence no discontinuities in torque exist at the instant of initiation of slip. This feature is one of the principal reasons for smoothness of the clutch action, since chattering in an ordinary dry friction clutch is mainly due to the difference between static and kinetic friction.

Because it has no axially moving parts, the clutch is extremely easy to build, consisting essentially of a driving and a driven member which do not change relative position, except in rotation. As slipping occurs only between extremely fine iron particles and between the iron particles and smooth-face surfaces of the clutch, and as all the surfaces are lubricated, wear is said to be practically nonexistent. Moreover, if any of the surfaces are worn off, the iron dust thus generated simply adds to the iron powder already in the oil mixture. The gaps, as normally employed, are fairly large; therefore any such wear will have negligible effect. In the clutches tested at the Bureau, no wear has been noted but because extensive life tests have not yet been run it is not possible to rule out wear completely.

First experiments performed at the Bureau consisted of taking the field structure of an ordinary small 2-pole motor, replacing the armature with a cylindrical iron rotor, and dropping the whole assembly into a beaker containing the iron-oil mixture. Voltage was then applied to the field windings and the locking torque on the rotor was examined. The torque was so great in this test that it was decided that the bearings must have "frozen" or that the rotor shaft had bent out of shape, although subsequent tests showed this not to be the case. A design as shown in Figs. 3 and 4 was constructed to check for the presence or absence of magnetic shear effect. This model was used for most of the experimental work at the Bureau. The bearings are external to the oil mixture, and by using a vertical shaft, oil seals and their attendant friction are eliminated. The results indicated that the first ex-

periments with the motor frame were quite valid in that large torques were no doubt due to the small gap present.

This motor as later remodeled, Fig. 5, was used with several sizes of rotors to determine the effect of gap length on the resulting torque. This particular type of assembly, using the conventional motor frame with laminated magnetic circuits, is especially suitable for magnetic clutches to be operated on alternating current.

Perhaps the most obvious application of the magnetic fluid clutch is for automobiles. Unlike fluid couplings of the type now common in automobiles, the clutch is not a speed-sensitive device; if the load is below the slipping torque of the clutch, no slippage occurs and the mechanical efficiency of the clutch is 100 per cent. The feature which particularly adapts the new clutch to automobile use is its easy controllability, which makes it especially attractive for use in automatic transmission where permanently engaged gear trains are clutched in and out, depending upon the speed ratio required. Since the amounts of electric power required to control the magnetic clutch are small, it is a simple matter to interlock the electric circuits with the speed, throttle setting, and power demands.

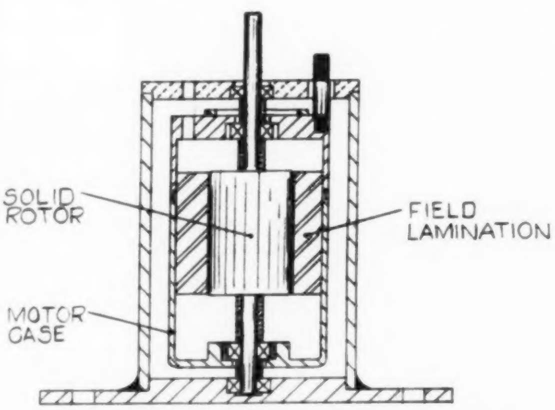


FIG. 5 CROSS SECTION OF SMALL MOTOR FRAME AND FIELD WINDINGS

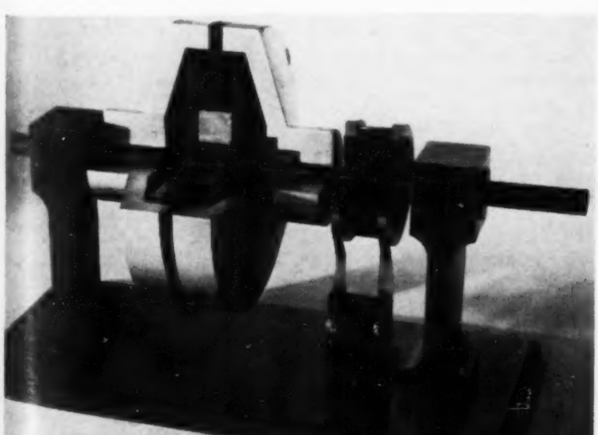


FIG. 6 CUTAWAY MODEL OF A SIMPLE MULTIPLE-DISK-TYPE MAGNETIC FLUID CLUTCH

(The electromagnet for energizing the magnetic fluid which normally fills the clutch casing utilizes the coil windings in the center of the clutch. By varying the strength of the magnetic field, which in turn controls the degree of locking between the driving ring and the driven plates, any value of torque up to locking can be transmitted to the driven member (attached to the right-hand shaft) by the driving member (attached to the left-hand shaft).)

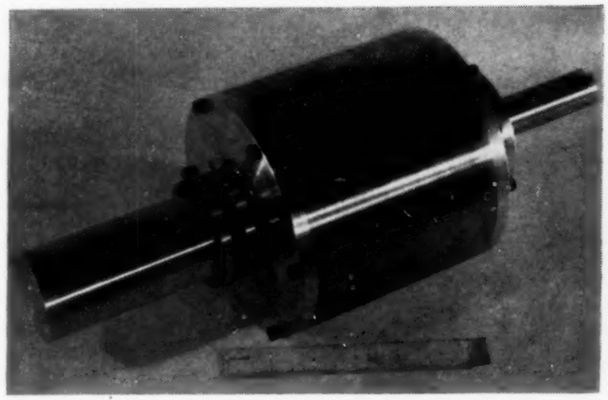


FIG. 7 LARGE ELECTROMAGNETIC FLUID CLUTCH OF THE TYPE SUITABLE FOR USE IN AUTOMOBILES AND MACHINERY

(This clutch, only 6 in. in diameter and $6^1/_2$ in. long, will transmit 40 hp at 3000 rpm.)

The field where these new clutches are expected to find their main application, however, is in servomechanisms. Here friction clutches have been used, but their lack of smoothness, the changes in characteristics caused by wear, their nonlinearity, and the poor reproducibility of results have given rise to great difficulties. The new clutch should go far toward solving such problems. While servomechanisms can be operated by variable-speed motors, hydraulic transmission, and many other means, clutches and brakes have the great advantage of low inertia-to-torque ratios. Electromagnetic clutches are particularly adaptable to serve as the final elements of electromechanical amplifiers.

It was found by experiment that the nature of the oil used in the magnetic fluid clutch has relatively little bearing on performance; hence silicone liquids may be employed with excellent results, enabling the clutch to operate at extremely low and high temperatures, a consideration of great importance in military applications.

Another broad field of applications is in constant-torque and overload devices where the clutch need never be de-energized. Permanent-magnet clutches are particularly useful for such service.

Television Network Extensions

TO meet the growing needs of television broadcasters, the American Telephone and Telegraph Company has announced plans to provide additional intercity network facilities this year extending from the East Coast as far west as the Mississippi River.

Included in the plans are 2000 miles of television network channels in the Midwest from Buffalo to St. Louis, which will be available in time for the football season this fall. The existing eastern network, which stretches along the coast from Boston to Washington, will also be increased and extended in time for the national political conventions in Philadelphia which start in June. In addition, it is expected that the new Midwestern network will be connected with the East-Coast network by the end of the year, linking these two sections of the country by television.

Two television channels—such that one program can be sent in each direction—will be provided in early October to

connect Cleveland, Toledo, Chicago, and St. Louis, and one channel to carry programs from this network to Buffalo.

Two additional television channels from New York to Washington to serve these cities and Philadelphia and Baltimore will be added to the present eastern network by June, thus doubling the television channels between these cities. During the political conventions, three of the television channels can be set up to carry separate programs from Philadelphia to cities on the network, both north and south. This network will also be extended south by the addition of one channel which will enable programs to be received in Richmond, Va.

In December the new Midwestern and the eastern networks will be linked by connecting Philadelphia and Cleveland with coaxial cable. It will then be possible for the first time for the same television program to be broadcast simultaneously by stations in cities linked to the network from Boston to St. Louis.

Airport Traffic

AT a recent meeting of the Management Division of the Washington, D. C., Section of ASME, Col. B. H. Griffin, manager of the Washington National Airport, presented a paper on airport management in which he stated that we have arrived again at the time when we can crowd the airway with more airplanes under safe traffic control than we can hope to take care of at the end of their journeys. The capacity of the terminal airport actually determines the capacity of the airways. From here on, the situation may be expected to get steadily worse.

Airline pilots now want runways 10,000 ft long. These runways are to be in pairs, parallel, and on a given airport the pairs are to be duplicated, and there must be at least four such pairs covering the cardinal points of the compass. Today many airports have mile-long runways, some with 10,000-ft runways, and still city councils are faced with the situation that their fields are inadequate.

The capacity of any airport is limited strictly to the number of airplanes it can handle safely under instrument flying conditions, and by that definition, most major fields, including Washington National Airport, are inadequate today. More planes are scheduled in than can be safely landed in times of peak activity. Between 5 and 7 p.m. at Washington National Airport, for example, 120 planes are due to land and take off. It is for that difficulty that we must find a solution. If we do not, air transportation is limited to good flying weather, and it can never succeed on that basis. It must compete with other forms of travel regardless of weather conditions, he said.

Colonel Griffin reported that a partial solution to the problem is under way, but it is only an alleviation and not a cure. This is the instrument-landing procedure developed by the CAA, now being used by 12 airlines at some 40 cities. Under previous conditions, the minimum ceiling under which airlines could land was 400 ft and the minimum visibility was a mile. Now, airlines whose airplanes are properly equipped and whose pilots are adequately trained may apply to the CAA and receive permission to make landings under 300-ft ceilings with three-quarter-mile visibility. The first airline to start this practice, Braniff Airlines, in the Southwest, has completed more than the required six months of safe operation, and has applied for and been granted permission to lower the minimums another 100 ft and another quarter mile. Thus Braniff airplanes are completing their trips when the weather at the destination is of 200-ft ceiling and half-mile visibility. This has affected the regularity of its services and put the line into a better competitive position with others serving the same cities. The CAA anticipates that all major airlines will be using ILS.

This then, is an improvement, but not a cure. It takes between three to five minutes for an airplane to land even with this valuable instrument aid. That means only 12 to 20 airplanes an hour can be handled at an airport with one usable instrument runway. And there are 12 to 20 others that want to take off on that same runway in that same hour.

According to Colonel Griffin, there are three real cures. First, build many large airports at various places about a big city, and equip each one with all the landing aids available and air-traffic control. Second, enlarge existing airports to perhaps two, three, or four times their sizes, and put in parallel runways separated sufficiently for simultaneous instrument landings. Third, develop an entirely different type of transport plane, one that will retain a reasonably high speed, but which will have a cruising and landing speed so low that its operation and control in traffic will be far simpler than are the planes of today. Of the three solutions, Colonel Griffin believes the improved airplane is the only final cure, at least until television or infrared ray is developed to the point where pilots can see the airports through fog. The first two are primarily palliatives and only possible cures.

Contrast an airplane able to fly slowly in perfect safety—say, at 40 mph—with the DC-4 which now must fly 140 mph to be safe while maneuvering for a landing, and which lands at about 100 mph. This slow airplane could enter the traffic pattern of an airport at a leisurely rate. Traffic controllers and the pilots could easily think ahead of the airplane. Other airplanes could come in safely a few hundred yards behind it. Therefore the capacity of a runway would be multiplied and safety would be increased. In fact, a pilot could contemplate without fear a forced landing between airports, something which today is almost sure catastrophe.

21-Ton Bomb

A BOMB almost twice the size of the largest previously dropped from an airplane has been test-dropped for the Army Ordnance Department by the United States Air Force at Muroc, Calif., Air Force Base.

The bomb, weighing 42,000 lb, was dropped from a B-29 Superfortress. The largest bomb previously dropped weighed 25,000 lb.

The purposes of the joint test operation were to obtain flight data on the path of the bomb after its release to enable Ordnance engineers to perfect the bomb's design, and to determine the effect on a plane suddenly lightened by 42,000 lb. A "dud" bomb was used for the test.

The bomb has a body diameter of $4^1/_2$ ft and an over-all length of 26 ft, 10 in. with fins installed. It was designed by the Ordnance Department for the Air Force early in 1945, but the first bombs were not completed until after World War II had ended. Known as a general-purpose bomb, it was intended for use against heavily armored enemy installations. While lacking the destructive power of atomic missiles, the 42,000-lb bomb has an advantage in that it leaves no radioactivity which might deny use of a captured area to the attacking force.

Preparatory to making the test drop, a portion of the body section under the wing was cut away, the rear bomb-bay doors were removed entirely, and the front bomb-bay doors were cut away to allow the nose of the bomb to protrude. When the bomb is attached to the B-29, approximately half of the missile hangs below the normal surface of the airplane.

To load the bomb, it was necessary to construct a concrete loading pit with a special mobile bomb lift. Hydraulically

operated and powered by external electricity, the lift can tilt, roll, and shift the bomb fore and aft, or sidewise, in order to position it in the bomb bay of the airplane. All operations are controlled by six hand levers which may be actuated by one man.

A series of approximately 12 test drops is scheduled with dud bombs. Later tests will be made with explosive bombs using various types of fuses. It is also planned to make some of these test drops from a Consolidated-Vultee B-36, the Air Force's largest bomber. Data on the airplane's behavior in all the tests will be recorded and cameras and precision instruments will follow the entire flight of the bomb from airplane to ground.

The data obtained from the drop-tests will be forwarded to the Ordnance Ballistics Research Laboratories at Aberdeen, Md., Proving Ground to determine the ballistic performance of the bomb, which will aid in the development of other bombs of this size. It will also be used in compiling bomb data tables for bombardiers' use.

2000-Hp Gas-Turbine Tests

APPROXIMATELY a year ago the Westinghouse Electric Corporation announced an experimental 2000-hp land open-cycle gas turbine. Since Aug. 1, 1946, the unit has been operated approximately 1000 hr, of which more than 850 hr have been accumulated since July 9, 1947.

Accurate over-all performance has been established by reliable measurements of power output, fuel flow, speed, air inlet temperature, and atmospheric pressure. The over-all fuel rate at full load is 0.78 lb per bhp per hr, which corresponds to a thermal efficiency of 16.7 per cent based on the fuel having a heat value of 19,500 Btu per lb. The maximum output obtained on the unit has been 2220 hp, when operating with an air inlet temperature of 48 F.

The compressor performance was established by measuring air flow, inlet and discharge pressures, and temperature rise. The adiabatic-compression efficiency was found to vary from 80 to 86 per cent over the entire operating speed and load range.

The turbine efficiency, as calculated, varied from 84 to 86 per cent over the operating range. This is about two points lower than that obtained with earlier test results and is due to the increased radial tip clearance found necessary for rapid changes in loading.

The combustion efficiency using specially designed air-atomizing nozzles was found by heat-balance calculation to vary between 94 to 96 per cent. These values agree closely with those obtained on separate combustion tests.

The unit is said to have been started from a cold standstill condition 350 times and has undergone several thousand rapid load cycle changes from no load to full load. Loading and unloading cycle tests have been made to prove its load-reponse characteristics. Probably the most severe load cycle will be in locomotive operation where continuous loading and unloading occur. This corresponds to rapid temperature changes of from 600 to 700 F on the turbine and combustor, the turbine inlet temperature being 1350 F at full load and 600 to 750 F at no load. To simulate locomotive operation, the unit was run at full load for 30 min, then immediately unloaded and run for 30 min at no load, whereupon load was reapplied in 10 to 20 sec, and the cycle repeated. This cycle was then changed to limit the loaded and unloaded time to 10 min instead of 30. To accelerate the test program, a further change to 5 min was made when tests established that this time was sufficient to heat or cool the parts of the unit subjected to rapid temperature variation.

The unit is started by using one generator as a motor. The time required is a function of the starting power available. When this power is limited to a maximum of 35 kw, the unit can be started in about $2^1/_2$ min. With a maximum of 80-kw starting power the unit can be started in 1 min; with 20-kw the time is 8 min. When the rotor reaches 15 per cent speed the acetylene igniters are turned on, and at 25 per cent speed the fuel is injected. The starting power is shut off at the end of $1^1/_2$ min, and the unit reaches a stable self-sustaining speed in about $2^1/_2$ min. A gas turbine of this type is said to be capable of operating at full capacity ten minutes from the time starting is initiated or even less if necessary.

In operating without an air filter at the compressor inlet, the compressor blading is said to become excessively dirty after approximately 100 hr of operation. This fouling with oily, dirty soot causes a drop in compressor efficiency of about two per cent. It is then necessary to wash the compressor blading, which consists of turning the unit over slowly with a starting motor, spraying a noncorrosive commercial solvent into the compressor inlet, allowing it to soak for a few minutes, and

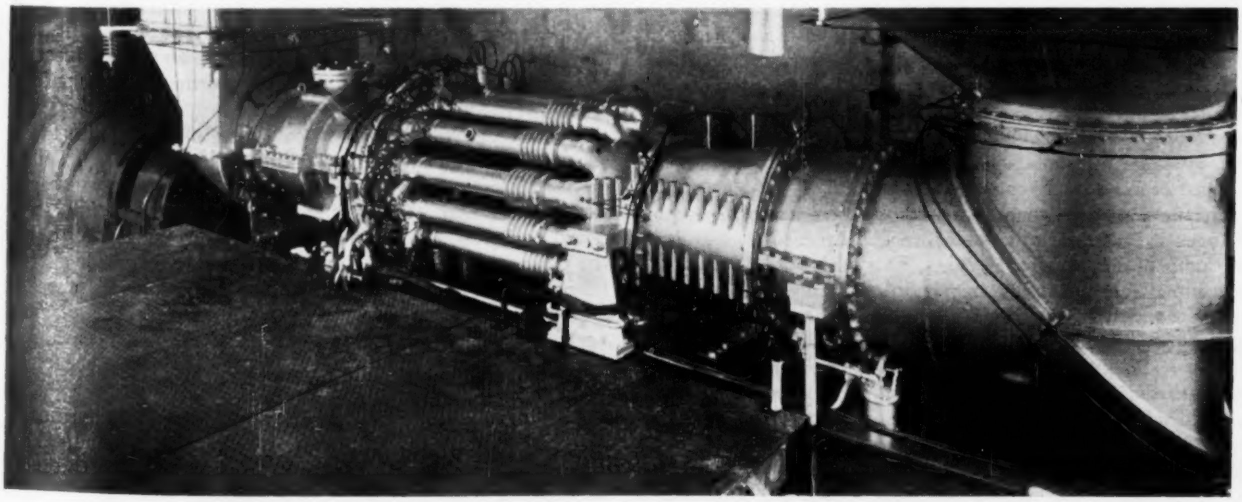


FIG. 8 EXPERIMENTAL 2000-HP GAS-TURBINE PLANT

(*Left to right:* Two direct-current generators, gear air intake, axial-flow compressor, multielement combustors, gas turbine, and exhaust.)

then washing it off with a steam spray. This can be done without dismantling any part of the compressor.

Two important casualties have occurred, one on the turbine and the other on the compressor. Approximately three months were required to restore the unit to operating condition in each case.

The first mishap was a failure of the turbine blading following 57 hr of operation. This was caused by a severe rub due to movement of the turbine-inlet bearing support on rapid temperature changes.

The second casualty was a failure of the stationary compressor blading after 125 hr of operation. The blades failed because of fatigue at the blade root due to forced vibration.

A No. 3 furnace oil has been used as the fuel for most of the testing. Tests have also been made with bunker C oil. Investigations made after 30 hr of operation with the bunker C oil revealed erosion of a critical part of the fuel nozzle that seriously affected its spray angle. Subsequent tests made with these nozzles showed that this change in spray angle, while seriously affecting the efficiency when using the bunker C oil, had no appreciable effect when the No. 3 furnace oil was used. A new set of nozzles, designed to eliminate erosion, is now in use.

Examination of the heated parts of the unit reveals no measurable creep of any stressed high-temperature part. Fluorescent penetrant tests have revealed no cracking or heat checking on the parts subjected to rapid temperature variations.

The future experimental program consists of continuing the cycle testing to gain further operating experience and to design and test controls for particular applications.

Wind-Tunnel Optics

THE first symposium on Wind-Tunnel Optics—a new field concerned with wind-tunnel instrumentation, especially for supersonic velocities—was sponsored recently by the National Bureau of Standards. Representatives of several government agencies interested in this work attended the meeting and took part in an informal program which brought out interesting problems in connection with this branch of optical engineering.

For many years wind-tunnel measurements were limited chiefly to pressures and forces produced by air moving about objects. With the relatively recent advent of high speeds, reaching and even greatly exceeding that of sound, it has become possible to observe the flow field by optical methods. This not only makes the wind tunnel a more versatile research tool, but, in particular, makes possible the observation of important phenomena associated with compressibility, which occurs at speeds now regularly achieved by projectiles, rockets, and by some of the jet-propelled planes that have been developed or are now on the drawing boards.

The flow of air around a solid object is accompanied by changes in pressure and this in turn gives rise to variations in the index of refraction of the air. This variation of index may be made visible by interferometric or schlieren apparatus. The design, construction, and use of this type of apparatus are embraced by the recently coined term "wind-tunnel optics." This is really a branch of optical engineering in which well-established principles of optics are applied as tools in an entirely distinct art. It distinguishes itself from other branches of engineering in that equipment is required of a different order of size from interferometric and schlieren apparatus constructed for the longer established practices. This in turn makes interesting demands on the glassmaker.

The construction of large glass disks of optical quality became a neglected art several decades ago when reflecting telescopes supplanted refractors. Now, however, disks 36 in. in diameter are often required and even larger constructions have been contemplated. Bureau staff members from the glass laboratory and the optical instruments laboratory discussed problems connected with the production of large windows and disks of interferometer and schlieren quality, both by casting and by other methods. Of particular importance is the elimination of optical heterogeneities by reduction of temperature gradients in annealing. Techniques for the measurement of strain and for testing the planeness and parallelism of surfaces were also described.

Although the optical principles back of wind-tunnel optics are well established, their applications to this relatively new field call for specialized techniques and interpretations. Schlieren methods, interpretation of results of interferometer measurements, and production of fringes with heterochromatic light were among the topics of this nature brought up for discussion.

Representatives of the Army, Navy, and Johns Hopkins Applied Physics Laboratory took part in the program, in addition to those from the Bureau of Standards. Although this symposium was limited to Government agencies, future symposiums are planned in which other interested groups will participate.

Assyriology

THE electric furnace, offspring of modern industry, has been placed into service by Yale University experts to salvage imperfect Babylonian clay tablets dating back to 3000 B.C., which record the religion, industry, and politics of a once great people.

The hazy cuneiform inscriptions on the clay tablets flash into sharp and bold relief when subjected to baking temperatures of 1400 F.

So successful has the Yale process become, after years of experimentation, that tablets are frequently received from other universities and museums for restoration to the same clarity which was present when a Babylonian imprinted his signature on a wet piece of clay.

Yale is said to have the largest collection of Babylonian tablets in the Western Hemisphere. In the collection are more than 25,000 of these durable clay pieces, the majority of which are records of commercial business transactions.

Aside from the commercial documents, the Yale collection contains literary pieces, works of moral philosophy and history, and, perhaps, the largest collection of mathematical cuneiform tablets in the world.

In the collection are many contracts of clay which were wrapped in clay "envelopes." The agreements were inscribed on the imperishable clay and then enclosed in envelopes. Both parties then affixed their seals with small artfully contrived cylinders. These, when rolled over the soft clay, left the personal design of the owners. This system made subterfuge a foolhardy practice since the contract could be checked easily by breaking the envelope and reading the original agreement. Letters likewise were sealed in clay envelopes bearing names of the addressee and writer as well as the latter's personal seal.

These ancient clay tablets are being discovered continually and many times they are almost illegible when found. Yale scientists have developed what is considered to be the most successful method of restoring the plaques.

The baking furnace was brought to Yale some 20 years ago. A long period of experimentation was required before the successful process emerged. In the early work, some of the

less valuable tablets which were used for experimental purposes even exploded when subjected to the extraordinary heat.

Tablets undergo a three-day period of baking and cooling. One day is required to reach the maximum temperature, and two days for cooling again to room temperature. After the heat-treatment, the tablets are soaked in water which is changed frequently, for two days. Often the clay pieces are seemingly worthless prior to heating because they are covered by debris or encrusted with salts. After the treatment the tablets are dried and loose pieces are fitted together like a jig-saw puzzle. Later, each stroke of the stylus is cleaned carefully of any remaining particles of material while the tablet is held under a microscope.

From the study of these and other types of clay tablets, assyriologists have pieced together a pattern of civilization which covers 3000 years of human history and culture.

Reports From Germany

Synthetic Crystals

GERMAN wartime attempts at making synthetic piezoelectric crystals for use in radio and electrical equipment in place of natural quartz are described in reports now on sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C.

The reports contain information about Germany's research program which consisted of (1) a search for a method of synthesis of quartz and (2) an exploration of a variety of substances which might be grown artificially and have favorable piezoelectric properties. Several of the methods described are believed to have promise. There was little commercial production of crystals.

Report PB-34040 describes a process for growing synthetic rock-salt crystals of good size. The report describes the heating of the furnace, introduction of the seed crystal, building up to the required diameter, and the lengthening of the crystal. The oven is maintained at 600 C (1110 F) for 8 to 10 days to eliminate any thermal strains before slow cooling is started. Different halide crystals of various sizes had been made by this process. Diagrams of the furnace and the chuck holding the seed crystal are shown.

Report PB-81281 discusses the growing and cutting of the crystals at two German firms. At one firm the crystals are grown between glass plates. The plates are separated by an amount depending upon the thickness of the crystal desired. A seed crystal, which is a small slab cut from another crystal, is inserted between the glass plates and the "sandwich" placed in a jar containing a Rochelle-salt solution. The report contains technical details of "growing" the crystals, and the cutting and grinding of the grown product.

High-Speed Photography

High-speed photography methods used in the study of fuel injection and the observation of flame travel are described in two reports on sale by the Office of Technical Services, Washington 25, D. C. Both of the methods described were developed in Germany and employed intermittent spark illumination.

The first report (PB-37778) contains information on a method of studying fuel injection photographically developed by Bosch research laboratory engineers.

The problem was to obtain moving pictures of an injection spray which lasted 0.003 to 0.005 sec. The interval between pictures was to be 0.001 to 0.002 sec, and the exposure time one millionth of a second.

The apparatus operates on the following basic principle: A sequence of sparks of very short duration, which occur during the required period, travel across a spark gap which is in focus with a condenser. The parallel directed light from the condenser is transmitted through the glass windows of a bomb where gas pressure exists equal to the engine's compression pressure. A silhouette of the spray will be thrown on sensitized printing paper or film. To obtain continuous pictures the drum bearing the paper or film must move steadily at the rate of 1.5 cm (0.59 in.) per 0.0002 sec, i.e., at a circumferential velocity of 75 meters per sec (246 fps).

The second report (PB-85201), describes a high-speed schlieren camera for the observation of flame travel developed at Luftfahrforschunganstalt, at Volkenrode, Germany. The camera operated at speeds up to 25,000 pictures per sec, the duration of each exposure being about one microsecond.

The schlieren apparatus was used for fundamental research on flame propagation in gas-air mixtures. At the time of the Allied occupation the research had not proceeded far enough to yield results of practical value, though satisfactory solutions had been found to the problems involved in the design of the camera itself, the report states.

The report gives the scope of the apparatus, optical arrangements, electric circuits, construction of the discharge tube, and results obtained.

Zinc-Base Bearings

Zinc-base bearings represent a new bearing material which is more than a substitute and therefore should receive engineering attention in the United States, according to a report (PB-42654) on German research on zinc-base bearings on sale by the office of Technical Services, Washington 25, D. C.

Practical German experience has shown that zinc-base bearings have applications in electric motors, driving rods, coupling rods, and axles of narrow-gage locomotives, and as bearings for streetcars, traveling wheels and transmissions of cranes, and in crushers and harvesting machinery. In addition, the fine zinc alloys proved excellent as main bearings as well as driving unit and auxiliary bearings for machine tools and wrist-pin bushings in small Diesel engines.

It is stated that compared with red brass, tin bronze, white metal with high tin content, and lead-base bearing alloys with a low content of tin, the zinc alloys are superior in tensile and fatigue strength, and in hardness. The zinc alloys are far superior to the standard bearing materials in respect to thermal conductivity; the coefficient of thermal expansion is higher than that of conventional bearing alloys. Zinc alloys can be used as solid bearings because of their high tensile strength at low temperatures.

Centrifugal casting should be used wherever possible since it produces a dense structure. In compound bearings the bearing liner thickness should not be less than 1.5 to 3 mm after finish-machining. Changing from red brass and bronze to zinc-base bearing alloys does not generally necessitate alterations in the design, the report points out. The zinc-base bearings can be used as full round or split bearings. The pattern (1 per cent shrinkage) common for red brass and gray-iron castings can be used for zinc casting.

The report contains test results which present a general idea of certain characteristics of zinc-base alloys. The tests were carried out at a velocity of 6 meters per sec (19.68 fps) using soft-steel shafts similar to SAE 1035 and SAE 1045. Ring oiling was employed. The tests indicate that zinc alloys are superior to copper alloys in respect to their resistance to bear-

ing disturbances. Their behavior under starved lubrication is similar to that of white metals, the report states.

Logarithmic Dividing Machine

An automatic logarithmic dividing machine which will generate any logarithmic, trigonometric, or linear scale up to 20 in. in length with an accuracy of 0.0002 in. is described and illustrated in a report (PB-79435) on sale by the Office of Technical Services, Washington 25, D. C.

The report is based on a visit to the factory of A. Nestler, Lahr Baden, Germany, where the machine was built and used in the manufacture of slide rules and draftsmen's scales.

The report states that this machine is "one of the finest in the world for accurately engraving slide-rule scales in an economical manner. The machine is a superb piece of engineering design and manufacture."

The entire machine weighs about a ton and is 21 ft long, 4 ft high, and 3 ft wide. The machine cuts at the rate of 60 lines per min, so that with a 30-cutter setup, 30 complete 10-in. scales an hour should be possible.

The scales to be engraved are mounted on a long table which is moved by a lead screw which is given angular rotations necessary to generate the desired scale. The control for these angular rotations comes from a cylindrical drum having a square helix cut on the periphery with ratchet teeth cut in the correct angular spacings.

The engraving cutters of chisel form are pivoted on frames above the scales to be cut. The cutters descend to the stationary table, draw a line of the desired length, and rise. The table then moves to the next cutting position.

The report includes 27 drawings and photographs illustrating various parts and mechanisms of the Nestler machine.

Also contained is a description and illustration of the Ott differentiograph, a mechanically driven machine, operating semiautomatically, which for a given curve, records the differential curve when a control lever is held parallel to the tangent of the curve in question. By changing over the control and recording equipment, the machine operates as an integraph. The same size paper is used for the initial and resultant graph, so that the resulting graph can be used without redrawing as a fresh initial curve in order to get the next higher derivation.

High-Frequency Heating

The Germans were fully aware of the industrial possibilities of high-frequency heating and were reasonably far advanced in the techniques involved, according to a report (PB-75851) on sale by the Office of Technical Services, Washington 25, D. C.

Among other purposes, the Germans used high-frequency heating in wood gluing, timber drying, cigarette manufacture, plastics heating, lice killing, and food processing, the report states.

Most of the work in high-frequency heating, however, was done by the large electrical firms, notably the Siemens-Schukert, A.E.G., and Telefunken firms in Berlin. The work at these firms was concerned mostly with gear hardening. Siemens-Schukert had used large apparatus in which whole gears were heated to hardening temperatures electronically. A preliminary design of a 200-kw output at 250 kc per sec had been used experimentally for hardening gears up to 130 mm (about 5 in.) diameter and 12 mm axial length. The techniques of gear-hardening using lower powers of the order of 20-kw output seems to have been fairly well established, according to the report.

Electronic timber drying had been tried by several firms experimentally, the report states. Beechwood and birchwood proved easier to dry in this manner than poplar, pine, and oak. One authority had concluded that the method of drying timber was uneconomic except in the case of rare woods such as are used in musical instruments. It was rumored, however, that the Russians were drying timber by electronic methods on a large scale.

Drying of finished cigarettes to the required moisture content had been done successfully just before the war using a frequency of 25–30 megacycles per sec but the war had prevented the introduction of the method into factories. Successful experiments had also been carried out on bulk-drying of tobacco.

Beryllium Uses

Efforts made to prolong life of automotive- and aviation-engine pistons by coating the tops with pure beryllium are described in a report (PB-2685) on sale by the Office of Technical Services, Washington 25, D. C.

The beryllium coatings were one centimeter thick and were bonded to aluminum pistons at from 800 to 1100 C (1472 to 2012 F). Laboratory measurements showed that the resistance to wear of such "capped" pistons is very good, the report states.

One section of the report describes the use of beryllium in refractory manufacture. The resulting products are said to be gastight at 1700 C (3092 F) and are dense, smooth, and resemble finest china. Beryllium has a melting point of 2530 C (4586 F) and crucibles made of it can be used at temperatures up to 2200 or 2300 C (3992 or 4172 F).

Smokeless Coal Burning

THE application of the principles of smokeless burning of coal to residential heating boilers of new design has been announced by Bituminous Coal Research, Inc., the national research agency for the bituminous-coal industry.

BCR states that its newly developed smokeless low-pressure heating boiler fills an urgent need in the field of coal-burning equipment and that a large potential market exists for manufacturers who produce this unit with the co-operation of BCR and Battelle Memorial Institute.

Demonstrations of a full-scale laboratory model are reported to show that the boiler will meet the requirements of even the most stringent city smoke ordinances. The boiler is inherently the magazine type and will hold enough fuel for 12 hours' operation at full output. The fuel feeds by gravity with little or no manual attention even with coking coals. Natural draft from an average chimney is sufficient to operate the boiler and automatic draft dampers can be applied to the boiler to regulate the heat release.

A wide range of bituminous coals can be burned in the boiler without any need for special processing or selection of the coal to insure smokelessness. Both coking and free-burning coals can be used.

The boiler developed by BCR in co-operation with manufacturers has already fulfilled laboratory requirements and is now in the stage of engineering design. Its principles are said to permit conversion of a conventional vertical sectional boiler to the smokeless magazine type.

Because the differences between the BCR and conventional boilers are few and simple, it is indicated that a manufacturer can incorporate the smokeless principles in new boiler construction without seriously changing his manufacturing procedure. This change-over entails the use of different types of

grates and firing door and adding one special boiler section. The slight increase in production cost will be more than offset by more efficient combustion, smokelessness, and generally improved operating performance.

Although the successful development has been accomplished on cast-iron boilers, BCR says that practical application of the same principles can be made to new steel boilers. BCR will meet with the principal manufacturers of heating boilers in the near future to discuss commercial production of the smokeless boilers.

Low-Temperature Test

MORE than 100 engineers from industrial organizations throughout the United States witnessed a test of various metal experimental vessels at liquid-nitrogen temperatures of below —300 F, recently staged at the Air Reduction Apparatus Research Laboratory by the International Nickel Company, Inc. The various metals tested were: $8^1/_2$ per cent nickel steel, AISI 2800; stainless steel, type 304; and carbon steel, ASTM A201.

Results of the test showed no material damage to $8^1/_2$ per cent nickel-steel and stainless-steel vessels, while a carbon-steel vessel was shattered upon the first impact. The vessels were fabricated from these materials with all major joints being x-rayed for defects, as well as being subjected to a 700-lb hydrostatic test.

The test consisted of dropping a weight on the vessels while filled with liquid nitrogen. For the $8^1/_2$ per cent nickel-steel and stainless-steel vessels, a weight of 292.9 lb was dropped from a height of 5 ft at the intersections of the longitudinal and transverse seams; at two locations along the longitudinal seam; and on the flange of the nozzle. For the carbon-steel vessel, a weight of 184.9 lb was dropped 5 ft near the longitudinal seam approximately midway between one end and the nozzle.

While $8^1/_2$ per cent nickel steel was commercially developed primarily for engineering structures at low temperatures, it is said to have a wide variety of applications at normal temperatures as well.

Limited experience indicates that the alloy probably will find use for sucker rods in certain types of corrosive oil wells and for oil-well tubing in deep wells. Several trial installations of seamless tubing have been used in black liquor evaporators in the pulp and paper industry. Excellent service is reported to have been obtained with this alloy in a trial in-

FIG. 9 DAMAGE TO CARBON STEEL (ASTM A201) VESSEL AFTER A WEIGHT OF 184.9 LB WAS DROPPED FROM A HEIGHT OF 5 FT AT A TEMPERATURE OF BELOW —300 F

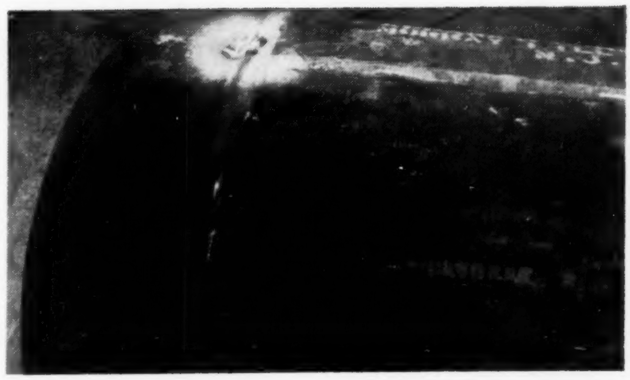


FIG. 10 $8^1/_2$ PER CENT NICKEL STEEL (AISI 2800) VESSEL SHOWING THE MINOR EFFECTS OF DROPPING A WEIGHT OF 292.2 LB FROM A HEIGHT OF 5 FT AT A TEMPERATURE OF BELOW —300 F

stallation of solder rolls used in the manufacture of tin cans.

In connection with corrosion resistance, however, the $8^1/_2$ per cent nickel alloy cannot be considered as a substitute for the 18–8 types of chromium-nickel stainless steels. It may be suitable for applications involving a particular type of corrosion. Nor is it suggested as a replacement for the low-alloy steels for applications in which high strength is the primary consideration. In certain respects this new nickel steel does have such advantages as combinations of valuable properties with moderate cost. This, beyond a doubt, will ultimately determine its proper position as an engineering material.

Future Power Needs

SOME of the phases of industrial electric-power consumption which have a direct bearing on the future growth of power in America were outlined by F. R. Benedict, manager, Industrial Engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa., at a press conference held at the Engineers Club, New York, N. Y., March 30, 1948.

He pointed out that industrial customers represent more than half of the power consumption by all customers. In the 20-year period from 1926 to 1946, during which time the number of production workers increased 40 per cent, the kilowatt-hour consumption per industrial worker increased 120 per cent from 3841 to 8426 kwhr. Of this consumption, about 70 per cent is for motors and lighting. There has been a gradual but definite increase in the horsepower of individual industrial machines brought about by the need for higher efficiency in production.

Of interest are the following figures that have been compiled on the amount of horsepower which backs up the American worker: 1849, very little; 1879, 1.3 hp; 1909, 2.9 hp; 1929, 4.86 hp; 1939, 6.4 hp; present, 7.2 hp. An historical study of these figures, which include both electric and mechanical power, shows that in 1909 about 2.0 of the 2.9 installed horsepower (about 69 per cent of the total) was mechanical, while in 1947 about 6.7 of the 7.2 installed horsepower (about 93 per cent of the total) was electric power.

With the greatly increased costs of labor, industry is looking with even greater favor now upon the application of highly specialized automatic machinery in industrial processes. According to the Bureau of Labor Statistics, the average earned rate for hourly employees in all manufacturing industries in 1939 was 63 cents an hour. By November, 1947, this rate had soared to \$1.26 an hour. This labor cost increase has focused

the spotlight on any methods that can help reduce production costs.

In the field of welding and brazing, Mr. Benedict said that there is about 1,000,000 kva of resistance-welding equipment in service, and it is growing daily. Industry has also installed about 50,000 kw of electric brazing furnaces and can readily absorb two or three times this amount.

For the brazing of small parts, where the time cycle can be short, induction brazing using high frequencies of 200,000 to 450,000 cps has shown extreme utility. Similar high-frequency equipment is also coming into extensive use in hardening operations where accurate control of the depth of hardness is required. He estimated that industry can absorb about 20,000 kw per year.

A careful review of the possible potential market for infrared heating indicates an industry-absorption capacity of about 200,000 kw of this type of heating each year for the next 10 years.

Induction heating, using frequencies from 60 to 200,000 cycles, is being actively investigated and may find wide use in industrial processes within the next few years. The power consumption of such equipment will be high, possibly as much as 5000 kw per unit and will be a continuous type of load. The steel industry alone could absorb 1,000,000 kw of this type of heat in a relatively short time, he said.

At the present time there is installed approximately 3,000,000 kw of electric-arc furnace equipment, and the figure is growing rapidly. If steel consumption continues to increase, there is a capacity in this field approaching 500,000 kw per year. Mr. Benedict also estimated that industry can very well absorb 50,000 kw of resistance-furnace equipment a year.

Approximately 10,000 kw of radio frequency heating at 200,000 cycles has been reflowing tin since 1943. If high output tubes in the order of 500 kw can be commercially developed, this type of heating will be attractive in the continuous annealing fields.

About 5000 kw of dielectric-heating equipment using frequencies up to 30 megacycles is installed. The industry-absorptive capacity appears to be about 10,000 kw per year.

He pointed out that fluorescent light definitely pays off in worker efficiency and also simplifies many of the difficult problems of air conditioning. While the new lamps give $2^1/_2$ times the amount of light for the same watts, industry must be sold on the idea of increasing light levels at least four times over present levels for high worker efficiency.

The development of the low-grade iron-ore industry will require tremendous amounts of power, as every pound of ore will have to be handled many times in the process. Conservative estimates place the requirements for power of this industry at 1,000,000 kw.

The chemical industry has an installed capacity in rectifiers of more than 200,000 kw, and this is increasing daily.

There is installed today in the aluminum industry about 1,500,000 kw of rectifiers alone, and this could very conceivably double within the next 10 years. As this type of load is normally on a 24-hr basis, an equal amount of generation capacity would be required.

The magnesium industry has an installed capacity of about 400,000 kw. It is not at all inconceivable that the industry will double its power consumption within 10 years.

Progress in coal-mine mechanization has been rapid, and the kilowatt-hours per ton of coal mined have been gradually increasing until it is now about $6^1/_2$ kwhr per ton. The mines will require at least double the capacity now installed in the industry, and it could very easily go to three times the installed capacity.

Power consumption in the oil-burner field alone would approximate an additional billion kilowatt-hours a year until the market is satisfied.

The Government has been carrying on extensive studies in the production of oil from oil shales, and if this should turn out to be economical, the industry may absorb as much as 10 kwhr per barrel of oil produced.

Mr. Benedict said that emphasis has been placed on the processing of coal to obtain oil and chemicals, and pilot plants are under construction. Such plants will use coal at a tremendous rate and coal production must follow. Present capacity is in the order of 600 million tons a year, but this will have to at least double to supply this new industry if we are to obtain as little as 20 per cent of oil from this source.

Stainless Steels Book

A NEW book, "Forming of Austenitic Chromium-Nickel Stainless Steels," compiled to give fabricators of metal equipment a better understanding of the exceptional adaptability of stainless steels to all modern processes of forming, was announced recently. This book presents a detailed description of the modern forming procedures as applied to chromium-nickel stainless steels and as practiced in the fabrication plants of the United States. Bending and straight flanging; forming of curved sections and tubing; deep drawing; die forming; forming of contoured-flanged parts; and forming by miscellaneous methods are some of the methods discussed in the book.

The specific examples of forming technique are supplemented by details of tool design and tool materials, lubricants, data on dimensions, and consecutive steps in fabrication.

The book will be available only through The International Nickel Company and copies, as long as they are available, may be reserved in the United States by mailing checks of $4 for each copy to The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y., and in Canada by addressing The International Nickel Company of Canada, Limited, 25 King Street West, Toronto 1, Ontario, Canada.

Electronic Memory

ELECTRONIC computers with a "memory" for storing numerical data and operating instructions in the form of electric and acoustic pulses at higher speeds were revealed at the annual convention and radio engineering show of The Institute of Radio Engineers, held in New York, N. Y., recently, by Isaac L. Auerbach, J. Presper Eckert, Jr., Robert F. Shaw, and C. Bradford Sheppard of the Eckert-Mauchly Computer Corporation, Philadelphia, Pa. They described a new system, said to be more than ten times as fast as former methods, in which memory is produced by means of a mercury column and crystals resonant at frequencies between ten and fifteen million cycles per second.

Increase in pulse rate makes it possible to store a greater amount of information in the electronic memory center so that a more compact unit, operating at much higher speeds, is made possible. Speed is important for the resolution of complex mathematical problems for advanced research and design in electronic science.

Utilization of higher frequencies in electronic memory networks permits the storing of an increased number of groups of data and instruction in a given period of time. Since memory time requirements differ in separate groups, the total elapsed time required to solve a problem is greatly reduced. The com-

puter is therefore able to complete its job in less time, just as a person who grasps and groups facts quickly is able to resolve and summarize them faster than a person with a slower grasp and acceptance of ideas.

Chrome-Base Concrete

A HIGH-STRENGTH, chrome-base refractory concrete, known as Kromecast, which is said to be capable of withstanding temperatures as high as 3100 F, has been developed by The Babcock & Wilcox Company, officials of its refractories division announced recently. The product is said to make available for the first time an easily installed concrete combining the refractory and slag-resisting properties of chrome-base materials with the ability to support loads at high temperatures.

The material, it is reported, can be poured into place as easily as ordinary concrete or applied by plastering or with a cement gun, possesses exceptional volume stability at temperatures up to 3100 F, and provides protection against attack by fuel slags, metallurgical, and chemical slags, molten materials, and other reactive products. It is claimed that this new concrete can be installed in a fraction of the time required for chrome plastics and, because of its strength at elevated temperatures, can be used to construct vertical walls and roof arches in many types of furnaces that formerly had to be made of less resistant materials.

Applications listed by the company where, it is said, the material will cut down construction time, reduce furnace maintenance, and contribute to longer sustained operating periods, include the following: furnace walls, hearths, and floors in metal-heating and forging furnaces; car tops; electric-furnace roofs; water-cooled boiler furnaces operating at high temperatures; furnace door and frame linings; patching furnaces which have been damaged; and forming special shapes quickly and inexpensively.

Quartz-Crystal Shortage

AN appeal for scientific help in finding new sources of supply or adequate substitutes for the vital crystals used in controlling radio communication frequencies was issued recently by a U. S. Army Signal Corps geologist.

The appeal, in the form of an open letter, appears in the *Journal of Economic Geology*, whose editorial offices are at Yale University. The letter is written by Hugh H. Waesche, geologist, Signal Corps Engineering Laboratories, Fort Monmouth, N. J.

In World War II quartz was found to be "without a peer as a frequency controlling element" and throughout the war was given air priority to keep an adequate supply flowing to the United States from Brazil, its only dependable source.

Mr. Waesche stated that at no time since 1943 has this country been free of the necessity of stock-piling quartz for strategic purposes; and crystal quartz has been listed invariably during the past two years as a strategic mineral on every public tabulation of minerals that must be stock-piled.

Men in the communications field are becoming increasingly concerned over the supply of a special type of quartz used in just about every piece of radio and radar equipment. The quartz plate which is so important is a thin, flat, electrically polarized slice cut from a crystal of the mineral quartz. Each crystal plate controls a radio frequency and crystal plates are of prime importance in all military and civilian communications.

The author stated that prior to World War II the Signal Corps accepted the use of quartz crystals for frequency-control purposes in essentially all electronic communication, navigation, and radar equipment operating in the audio- and radio-frequency spectra up to and including the ultrahigh-frequency channels.

Some equipment required a complement of 100 or more crystal units plus spares and replacements for satisfactory operation. As a result, more than 70 million crystal units were manufactured for the Army, Navy, and Air Forces, requiring more than 4 million lb of radio-grade quartz, between January, 1942, and V-J Day.

Military and civilian uses of quartz in the field, as well as laboratory studies, have confirmed this premise and as of this date, no means of highly stable frequency control superior to quartz has been discovered. It appears certain that the demand for use of quartz for frequency-control purposes will continue at a high level because its outstanding value in this service will be a strong consideration and determining factor in development and use of military electronic equipment, he said.

Quartz itself is one of the most abundant mineral constituents of the earth's crust. However, its piezoelectric use, or special use for communications work, is very exacting in its requirements, thus limiting its use to larger crystals of pure quartz.

Quartz is not the only electrically polarized crystalline material. More than 175 substances have been reported to have the necessary properties in varying degrees. Three other materials in particular offer promise but the big problem is that none of these substitute materials occurs plentifully in nature or in suitable form.

In his article, the geologist appeals for any information concerning the location and quantities of any materials such as tourmaline, nepheline, and berlinite occurring in large crystalline form, relatively clear and free from defects.

According to the article, the Signal Corps has been so concerned over the future natural quartz supply for frequency-control application, that it has launched a program for synthesis of substitute materials. Results to date have been gratifying but in no way affect the present Signal Corps' desire to promote consideration for radio-grade quartz wherever explorations of any kind are conducted in Central and North America.

To aid in expediting matters, Signal Corps engineers are working closely with geological groups and many government agencies and research organizations.

Arc-Welding Motion Picture

TO help review the fundamentals of welded design and to assist the designer and engineer to use arc-welded steel in the design of all types of machinery in many different industries, The Lincoln Electric Company has recently released a new animated motion picture, "Designing Machinery for Arc Welding."

This 16-mm sound-color production describes the functional approach to machine design in a simple, interesting way. It compares various materials and presents a study of load factors, stresses, rigidity, performance, and appearance. It explains how welded design permits freedom of planning, speeds up fabrication, reduces weight, and permits greater strength and rigidity from less material.

The new movie, which has a running time of approximately fifteen minutes, is available from The Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio, at no charge (except transportation) by all interested industrial organizations, technical societies, schools, colleges, and other groups.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Applied Mechanics

THE following papers are to be presented at the National Meeting of the ASME Applied Mechanics Division, Illinois Institute of Technology, Chicago, Ill., June 17–19, 1948. Advance copies of these papers are now available and may be purchased from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

Vibration of a Cantilever Beam With Prescribed End Motion, by G. A. Nothmann, Jun. ASME, Cornell University, Ithaca, N. Y. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-3** (in type; to be published in the *Journal of Applied Mechanics*).

A cantilever beam, vibrating as a result of prescribed motion of its end, is studied with particular regard to the force required to maintain such motion. The end motions in the four basic problems solved are as follows: uniform acceleration; uniform acceleration, uniform velocity; uniform acceleration, uniform velocity, uniform deceleration, rest; and sinusoidal pulse, rest. Illustrations show the end-force variation for each of the problems considered. The method of analysis indicates that the end force on the beam may be obtained in each instance by superposition of certain basic components. The results show how the parameters of the prescribed motion determine the magnitude of the fluctuations and the direction of the corresponding end force.

Flow of a Compressible Fluid Through a Series of Identical Orifices, by C. S. L. Robinson, Mem. ASME, Bethlehem Steel Company, Quincy, Mass. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-4** (in type; to be published in the *Journal of Applied Mechanics*).

This paper contains a method for computing the weight flow of a gas or vapor through a number of like orifices. It is based upon the general equation for a single orifice and upon certain reasonable assumptions. There are included curves showing the influence of the number of orifices. For expansions beyond the over-all critical-pressure ratio, the effect of each additional orifice is increasingly reduced. For example, increasing the number of like orifices from 6 to 7 will decrease the flow only about 5 per cent. Two applications of this study are suggested, i.e., to multiple-orifice devices for heat-exchange equipment, and to labyrinth packing for shaft seals.

The Decay of Isotropic Turbulence by F. N. Frenkiel, Cornell University, Ithaca, N. Y. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-5** (in type; to be published in the *Journal of Applied Mechanics*).

The equation of decay of isotropic turbulence is determined in the two cases of large and small Reynolds number of turbulence by using the von Kármán-Howarth equations and applying Loitsianskii's theorem of the conservation of the disturbance moment. The theoretical curves are compared with the results of measurements behind grids, made by various experimenters in the United States and in England. The decay of the longitudinal turbulent energy seems to agree quite well with the theoretical equations for large Reynolds number of turbulence. The theory does not give the variation of the transverse scale of turbulence measured in the experiments, but only the "disturbance length," which is a function of the longitudinal correlation. Thus the comparison for the scale is only qualitative. It is not possible to show agreement with the theoretical variation of the scale deduced from the equations. The difference is explained by the imperfect isotropy, which has a much greater influence on the variation of the scale than it has on the energy decay. The present comparison of the theory with the experiments differs from similar prior comparisons by the fact that the decay is given as a function of the initial conditions of the turbulence at a chosen moment, without using arbitrary constants.

Advance Digests

of papers to be presented at ASME meetings are included in this month's ASME Technical Digest. Premeeting copies of the complete papers are available and may be purchased from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

How to Order ASME Papers

PAMPHLET copies of ASME papers referred to in this section are available from the Society at 25 cents per copy to members; 50 cents to nonmembers. Papers published in MECHANICAL ENGINEERING are not included.

To facilitate ordering pamphlets, coupon books are available to members at $2 for 10 coupons; to nonmembers $4. Each coupon will be accepted in payment of one copy of an ASME paper.

Coupons may be used to purchase pamphlet copies of papers which will be presented at national meetings during 1948, including the 1947 Annual Meeting. (In ordering give title, author, and paper number. State number of copies wanted.)

Coupon books and copies of papers are obtainable from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y.

A Law of Work Hardening, by A. M. Freudenthal, Hebrew Institute of Technology, Haifa, Palestine, at present University of Illinois, Urbana, Ill., and M. Reiner, The Standards Institution of Palestine. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

Based on the "blocking" theory of the strength of a polycrystalline metal, a law of work hardening is derived and checked experimentally on mild steel deformed by wire drawing up to a deformation of 4.6 in the logarithmic measure. The law correlates the recoverable

strain work with the total work of deformation in a series of exponential functions, the number of which corresponds to the number of sizes of crystal grains present in the annealed state.

The Partitioning of Matrices in Structural Analysis, by S. U. Benscoter, National Advisory Committee for Aeronautics, Langley Field, Va. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-7** (in type; to be published in the *Journal of Applied Mechanics*).

The practical value of the partitioning of matrices in structural analysis is illustrated with the solution of two multicell box beams in torsion. The desirability of partitioning a matrix is determined from a simple principle relating to the pattern of the matrix. Typical patterns of matrices that are readily inverted are noted and employed in the solution by matrix partitioning.

Large Deformations of an Elastic Solid, by E. G. Chilton, Shell Development Company, San Francisco, Calif. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-8** (in type; to be published in the *Journal of Applied Mechanics*).

Hencky's stress-strain relation for large deformations of a rubberlike material is reviewed. It is then applied to the specific cases of pure tension, compression, bending, shear, and torsion. Each of these cases is verified experimentally on samples made from natural rubber. Particular emphasis is placed on the shear and torsion analysis because of its importance to practical applications.

Symposium on Flow and Fracture of Metals

THE following papers constitute part of a symposium on the flow and fracture of metals and are also scheduled on the program of the June, 1948, ASME Applied Mechanics Division Meeting. The symposium is sponsored jointly by the Research Committee on Plastic Flow of Metals, and the Applied Mechanics and Metals Engineering Divisions of the ASME.

Experimental Studies of Biaxially Stressed Mild Steel in the Plastics Range, by S. J. Fraenkel, Jun. ASME, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-1** (in type; to be published in the *Journal of Applied Mechanics*).

This paper describes static tests of tubular specimens of medium steel under biaxial stresses and at room temperature. The purposes of the tests were: (1) to obtain an experimental check on the so-called "third rule of plastic flow;" (2) to study the absorption of energy as a function of the biaxial stress ratio; and (3) to determine the effect of the path of loading as symbolized by the strain path. Within the range of conditions investigated, the path of loading was found to be immaterial. A relation between strain energies absorbed under biaxial and uniaxial stress states up to a common maximum strain is tentatively formulated.

The General Proof of the Principle of Maximum Plastic Resistance, by A. H. Philippidis, Stanford University, Calif. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-2** (in type; to be published in the *Journal of Applied Mechanics*).

In this paper the general proof of the principle of maximum plastic resistance of M. Sadowsky is given.

A New Method of Making High-Speed Compression Tests on Small Copper Cylinders, by E. T. Habib, David Taylor Model Basin, Navy Department, Washington, D. C. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-9** (in type; to be published in the *Journal of Applied Mechanics*).

In mechanical gages used to measure the pressure from an underwater explosion, small copper cylinders are compressed at high speeds. This paper describes the test apparatus designed for the dynamic calibration of these cylinders, presents the results obtained with this apparatus, and compares the results with those obtained by other experimenters.

The test equipment consisted of an air gun for blowing a hardened-steel piston against a copper cylinder located on a heavy anvil at the end of the gun barrel and auxiliary equipment for measuring the energy of the piston. The steel piston was accelerated by means of compressed air and then allowed to strike the copper cylinder. The length of the copper cylinder was measured before and after compression. The velocity of the piston was measured immediately before impact and immediately after impact. The change in energy of the piston was taken as the energy absorbed by the copper cylinder. A new copper cylinder then replaced the old one and the procedure was repeated at a different velocity. By using one piston accelerated to various striking velocities, a curve of energy absorption versus deformation may be plotted. By using several pistons of different masses, several energy-deformation curves may be obtained.

Curves of conventional stress versus conventional strain were derived from the energy-deformation curves by numerical differentiation. These curves were then revised by plotting the true stress $\bar{\sigma}$ against the natural strain $\bar{\epsilon}$. These stress-strain curves were compared with results obtained by other investigators both in tension and compression.

Some Properties of a Mechanical Model of Plasticity, by H. Frederic Bohnenblust and Pol Duwez, California Institute of Technology, Pasadena, Calif. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-10** (in type; to be published in the *Journal of Applied Mechanics*).

Several investigators have proposed various mechanical models by which plastic deformation in metals may be represented. It is shown in this investigation that a simple model may also be used for the computation of the energy of cold-hardening which is stored in a metal undergoing plastic deformation. The analysis indicates that the energy of cold-hardening may be deduced from a simple graphical integration based on the stress-strain curve. Annealed copper is given as an example, and the results are compared with the measurements of previous investigations.

Plastic Deformation of a Circular Diaphragm Under Pressure, by A. Gleyzal, David Taylor Model Basin, Navy Department, Washington, D. C. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-11** (in type; to be published in the *Journal of Applied Mechanics*).

In this report a numerical solution is given of a set of equations consisting essentially of three plasticity laws, two strain-displacement laws, and two equilibrium laws, which describe the action of a clamped, thin, circular diaphragm as it yields plastically when pressure is applied to one side. The stresses, strains, thickness variation, and deflections for

any thin circular diaphragm of a given material may be computed by the numerical integration of the equilibrium conditions, the geometric conditions relating to displacements and strains, and the stress-strain laws. The solution may be reduced to the solution of a second-order differential equation with the radial distance r as independent variable. The solution depends upon an experimentally determined function, $\tau(\gamma)$, which describes the stress-strain properties of the material, and upon three parameters, the pressure p, the original thickness h_0, and the radius a of the clamping ring. It is found that for a given material, a family of curves with pa/h_0 as a parameter serves to predict the solution for any thin circular diaphragm of the same material.

This analysis has been carried out for a particular function based on results of a tensile test made on a specimen of medium steel. Graphs of theoretically and experimentally determined values of deflection, radial and circumferential strains, radial and circumferential stresses, and thickness, corresponding to various pressures, are presented which apply to all diaphragms made of the same steel as this specimen.

The Effect of Size and Stored Energy on the Fracture of Tubular Specimens, by Evan A. Davis, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-12** (in type; to be published in the *Journal of Applied Mechanics*).

Internal-pressure tests on tubular specimens are described in this paper. Tests were run on three sizes of specimens. In one half of the tests a high-pressure chamber was used in connection with the specimens to store additional energy in the test system. Both pure internal pressure and pure circumferential tension tests were made. The size effect as shown by the tests was negligible. The effect of the stored energy showed up only after the fracture actually started. In the high-energy tests the extent of the fracture was much greater than in the low-energy tests.

A Generalized Deformation Law, by Evan A. Davis, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-13** (in type; to be published in the *Journal of Applied Mechanics*).

According to Hooke's law the magnitude of infinitesimal elastic strains depends upon two independent constants. In this paper equations are developed which express the magnitude and the distribution of the strains in terms of two independent functions of the stresses. One function is related to the stress-strain diagram while the other is concerned with the distribution of the strains in a state of combined stress. The equations are easily adaptable to the relations between the strain rates and the stresses in combined stress creep tests. It is the opinion of the author that two independent functions are necessary and that the behavior under a state of combined stress cannot be predicted from data obtained in pure tension tests.

The Stress-Strain Laws of the Mathematical Theory of Plasticity—A Survey of Recent Progress, by William Prager, Mem. ASME, Brown University, Providence, R. I. 1948 ASME Applied Mechanics Division Meeting paper No. **48—APM-14** (in type; to be published in the *Journal of Applied Mechanics*).

Typical stress-strain laws of flow and deformation types are discussed with particular reference to the conditions of continuity and uniqueness which these laws must fulfill if they are to make sense physically. Alternative forms of some of these laws are presented, and conditions are discussed under which different laws yield identical results. It is shown how these laws may be generalized so as to fit test data more readily. Methods of integration are indicated and the use of variational principles is stressed.

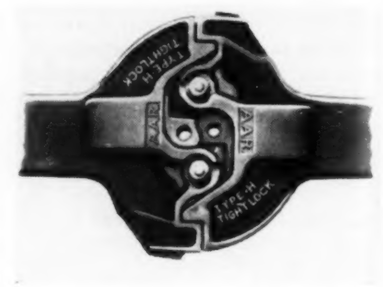
Railroad Car Couplers

The Association of American Railroads Standard Car Coupler, by Hubert L. Spence, National Malleable & Steel Castings Co., Cleveland, Ohio. To be presented at the 1948 ASME Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5, 1948. Paper No. **48—SA-4** (mimeographed).

Projecting from each end of every railroad car in America is a coupler assembly of about 400 lb of steel castings. Each of these four million car couplers must be capable of coupling with every other railroad coupler in the country and of operating freely and safely over all track curvature, humps, switches, and industrial sidings.

The AAR Standard freight-car coupler is assembled from six unmachined castings, each manufactured by seven steel foundries, and is designed and made to insure complete interchangeability and correct assembly of each part.

The only tool required to put the coupler together is a chisel or screwdriver with which to spread a $^3/_8$-in. cotter pin, the final step. It is then impossible to remove any part without first removing the cotter pin.



TIGHTLOCK COUPLER FOR PASSENGER-CAR SERVICE WHICH ELIMINATES NEARLY ALL FREE SLACK

The paper describes how the coupler design provides for several automatic functions through the co-operation of the internal parts. These functions are as follows: Anticreep, to insure that the locking device shall not creep or bounce and allow the coupler to unlock; lock-set, to allow coupler to be set for unlocking so that the switchman does not have to be present when the cars pull apart; and knuckle-throwing, which automatically disengages the lock when a knuckle is opened for coupling.

For passenger-car service, the AAR Standard Tightlock coupler has been adopted, which incorporates additional safety functions. By machining certain parts, the practically complete elimination of free slack when intercoupled has been attained. These benefits have been achieved without losing the benefits of standardization.

At present, a Tightlock-type of coupler is being developed for freight service.

Machine Design

Ball Bearing Slides, by Conrad Jobst, Mem. ASME, Owens Brush Company, Toledo, Ohio. 1947 ASME Annual Meeting paper No. **47—A-42** (mimeographed).

Modern mechanical design and production demand increasing output and high precision in machine products with longer life between shutdown for either repair or adjustment. These requirements indicate the more widespread use of preloaded ball bearings in slide mechanisms in order to eliminate the slight inaccuracies developed in the ordinary slides.

Slide mechanisms that are not preloaded are subject to tilting if the load is in any part eccentric or as the live load changes from no load to full load. Preloading produces high stability in a slide because operating loads merely modify the total load. Preloading sets up in the

mechanism couples which are available to resist the couples set up by off-center or eccentric loading. A number of examples are listed and described, varying from an ordinary slide in which gibs are used to maintain alignment, to screw-fed mechanisms for developing high pressures used in the forming of plastics. Each example given shows the advantage of the preloaded slide, and in some cases statistics are given proving the increased life and decreased wear provided. In one example it is shown that in 20 years of operation at full production, a ball slide made about 70 million strokes without losing any noticeable amount of preload.

While preloaded slides are especially applicable in the construction of mechanisms where delicacy and sensitivity are requirements, they are equally applicable in heavy-duty equipment.

In one example, a machine making up to 25 adjustments per second uses the preload principle in all moving members. This gives entire freedom from cocking and offers a highly practical design.

Among the heavy-duty equipment covered is a mold-clamping device with 1,000,000 lb clamping pressure. The carriage of this equipment weighs 5000 lb, but it requires a spring pressure of only 150 lb to move the carriage including the die. Preload on the balls in this case is approximately 50 tons.

Where extreme accuracy and high pressures are involved, the backlash between the screw thread and the nut can be eliminated by inserting balls between the threads, forming a preloaded ball bearing to take up the thrust.

Electrification Increases Productivity of Small Turret Lathes, by R. H. Clark, The Warner & Swasey Company, Cleveland, Ohio. 1947 ASME Annual Meeting paper No. **47—A-76** (mimeographed).

The electrification of a small turret lathe was used as the basis for the study of the factors comprising floor-to-floor time. Brass served as the basis from which increased production through electrification was investigated.

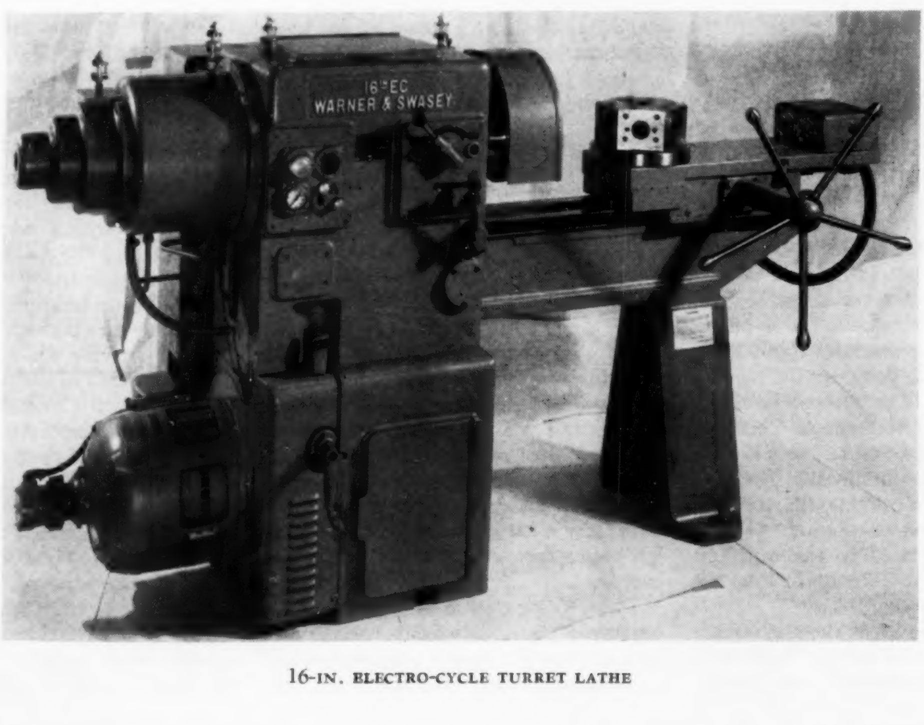
An analysis of the four major time factors proved that 50 per cent of the floor-to-floor time was devoted to headstock handling and that consequently a reduction in this factor should be the first investigated. As a first step in this direction the effort was directed to transferring as many manual operations to automatic control as possible. The reduction of the operator fatigue is hard to estimate but shows in the increased production at the end of the day. Proper positioning of the chuck, for example, enables the operator to establish a rhythm which greatly speeds the loading operation.

The first step in design was to incorporate a motor capable of maintaining speeds consistent with present machine practices and to start, stop, reverse, and change speeds under heavy loads. Three speed changes were provided by means of steel-cable V-belts, and a nonrotating air cylinder for chucking replaced the conventional air cylinder. Other inertia reductions were also made and a NEMA frame 326, $5^{1}/_{2}$-hp, 1800/900-rpm motor was selected. This oversize frame was chosen to dissipate the heat under rapid reversing service and to produce high starting and reversing torque. A reversal is taken to be one directional change.

Motors were evaluated on the basis of the maximum permissible number of free rotor reversals per minute without overheating and the rotor inertia. These factors were used in a formula by which the capacity of machines without heating could be determined. Calculations were made and charts prepared to show the interrelationship of other factors such as starts, stops, speed changes, and reversals. By the use of these charts the maximum productivity of the machine can be determined as limited by motor heating.

On the basis of the motor selected a 16-in. lathe was built to make full use of its capabilities and to satisfy as many of the user's requirements as possible. Seven features were decided on, ranging from the start of the spindle at the approach of the tool to the work to the positioning of the spindle after stop for loading and unloading.

All functions except positioning are directed by an automatic drum at the end of the slide opposite the turret. Four cam drums are geared to the turret and index with it. The automatic control is one of turret position rather than operation sequence which makes it im-



16-in. electro-cycle turret lathe

possible to get out of synchronism. The turret may be put through any changing sequence of operation without affecting the preset functions. Automatic switches are located in a watertight box on the back of the turret saddle.

The spindle reverses within approximately one-eighth revolution of the same point each time. Consequently self-opening die heads and collapsible taps are not necessary. A chart shows the safe number of revolutions overrun beyond the switch for thread speeds and threads per inch.

Curvature-Acceleration Relations for Plane Cams, by M. L. Baxter, Jr., Mem. ASME, Gleason Works, Rochester, N. Y. 1947 ASME Annual Meeting paper No. **47—A-77**(in type; to be published in Trans. ASME).

The machine designer is faced with the problem of determining the smallest cam capable of producing a prescribed motion, or the extremes of motion that can be obtained from a cam of limited size. Cam curvature presents an important limitation in cam design and is discussed from both the mathematical and geometrical standpoints. In this discussion the pressure angle, the second design factor, is the angle between the direction of force and the direction of instantaneous motion. Flat and circular followers are considered for both translational and rotational follower motion. Formulas not previously published are developed for obtaining the curvature. A primary rule in cam design is that the required motion must not produce a radius of curvature of the pitch curve less than the radius of the follower. Five cases are discussed involving both circular and flat followers in both translation and rotation.

A nomenclature of symbols used in the formulas that are developed is given at the beginning of the discussion and the characteristics of follower motion are expressed mathematically. The various formulas developed cover design for the five cases discussed. A discussion of the application of the formulas follows.

The geometrical construction for the center of curvature is covered from the standpoint of instantaneous centers. The theorem of three centers to a system of five bodies is employed. The five bodies constitute the frame, the cam, the follower, the contact normal, and an auxiliary body geared to the cam and carrying the instant center of the follower relative to the cam.

An example is given in the application of the formulas to a design problem in which definite stipulations must be met.

Production Design Panel

Design for Production, by G. C. Landis, The Lincoln Electric Company, Cleveland, Ohio. 1947 ASME Annual Meeting paper No. **47—A-98** (mimeographed).

Changes in design, however minor, should be treated as a new design of the part affected. Consequently transfer of information between the engineering department and the production department must and should occur daily. The engineer should adapt his designs to the manufacturing facilities available and correlate the methods of manufacture with the operations existing in the plant.

A blueprint, for some unjustifiable reason, carries a sense of finality about it. For this reason, an earnest attempt must be made to get all of the brains into the design of the product before the design is put on paper. Thinking must run along the lines of who does what, rather than the pure functions of the engineering, manufacturing, and cost departments.

When the need for a new product has been determined, the job is turned over to the engineering department and takes its place as a new development.

After a first unit has been built, which is considered as satisfactory for a point of departure, a small production lot should be planned which is four times as large as anyone considers necessary to establish methods of manufacture.

This lot is then used as follows: first quarter, primarily to check performance and tooling; second quarter, to make sure the drawings are up to date; third quarter, to work out methods and establish prices; and fourth quarter, to train production operators.

Co-Ordination of Design and Manufacture in the Transportation and Generator Division of Westinghouse, by P. C. Smith, Westinghouse Electric Company, East Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-99** (mimeographed).

There is and must of necessity be considerable overlapping of the duties and responsibilities of design and manufacturing engineers. There can be no sharp boundary line where design engineering activity stops and the manufacturing activity begins. The design engineer is the key man, but he leans heavily on his teammates and the manufacturing engineer.

The Westinghouse Corporation is organized on a divisional basis, with each division acting as a company within a company. The transportation and general division manufactures a variety of electrical and industrial pieces of equipment, with orders ranging from fairly large quantities to those which require only one machine. Each of the individual departments, such as engineering, manufacturing, and sales, is subdivided into sections and units.

The co-ordinated activity of the various supervisors of these groups in connection with product development is called production planning. When the need for a new product is established the following steps are taken: (1) Make preliminary investigation and cost estimate; (2) authorize development; (3) enter development order; (4) design product and complete drawings; (5) make manufacturing study; (6) approve for manufacture; (7) manufacture first unit; and (8) verification report to management.

Product Design for Economical Manufacture, by L. M. Clement, Avco Manufacturing Corporation, San Francisco, Calif. 1947 ASME Annual Meeting paper No. **47—A-100** (mimeographed).

The cost of a product, to a large degree, is determined by engineering design, which is affected by a number of factors not usually apparent. It starts with the objectives of the engineering department, its organization, its methods, its open-mindedness, its wholehearted and willing co-operation with other departments within the organization, and its esprit de corps.

This paper deals with the various aspects of engineering leading to the economical design of mass-produced, highly competitive radio and television sets, consumer home appliances, and the importance of these factors.

The organization of an engineering department has the following objectives: (1) The design and styling of products with better performance and superior features than the competition; and (2) the constant striving for simplification and standardization of designs and methods, consistent with minimum "over-all" cost. One scheme which has worked satisfactorily and resulted in good product design for economical manufacture consists of the following four main groups: (1) Research and advance development; (2) radio-product design; (3) appliance-product design; and (4) engineering services.

Proper organization and supervision, coupled with capable men with open minds and a spirit of willing co-operation

and adequate facilities properly co-ordinated, are the best insurance of economical product design.

Lubrication

Measurements of the Combined Frictional and Thermal Behavior in Journal-Bearing Lubrication, by S. A. McKee, H. S. White, and J. F. Swindells, National Bureau of Standards, Washington, D. C. 1947 ASME Annual Meeting paper No. **47—A-61** (mimeographed).

Data were obtained in tests with a four-bearing friction machine which show that an increase in the load on a journal bearing produces a proportional increase in frictional torque, when other conditions of test are held constant. Under these same conditions an increase in load also produces a proportional increase in the fluidity of the oil in the bearings. These two effects are the result of the combined hydrodynamic and thermodynamic actions involved in journal-bearing operation with forced-feed lubrication.

The increase in torque is influenced by the viscosity of the oil, the oil-inlet temperature, the oil-feed pressure, the shaft diameter, the clearance-diameter ratio, and the length-diameter ratio. The increase in fluidity is influenced by the same factors and also by the speed of the journal.

Empirical equations are derived for the fluidity-pressure relationships for certain conditions. Also, a graphical method is given for the use of this relationship in estimating safe bearing loads.

Data pertaining to the thermal behavior of the bearings and apparatus are given in an appendix. These indicate that with forced-feed lubrication most of the heat generated in the bearings is carried away by the oil flowing through them.

Gas-Turbine Railway Vehicles

Gas-Turbine Railway Vehicles, by W. Giger, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1947 ASME Annual Meeting paper No. **47—A-134** (mimeographed).

A 4000-hp coal-burning gas-turbine plant for locomotive use, including electrical equipment, is now under construction for the Locomotive Development Committee of Bituminous Coal Research, Inc. It is of the open type and works with a maximum gas temperature of 1300 F at the turbine. With an atmospheric temperature of 70 F, at a speed of 5700 rpm, the output at the turbine shaft is 4200 shp. A reduction gear is used to reduce the turbine speed of 5700 rpm to 1350 rpm, suitable for the four direct-current generators and for the auxiliaries, which in case of the coal-burning gas turbine, absorb about 160 hp, and which are supplied from a three-phase generator specially provided for, or mechanically driven as the case may be.

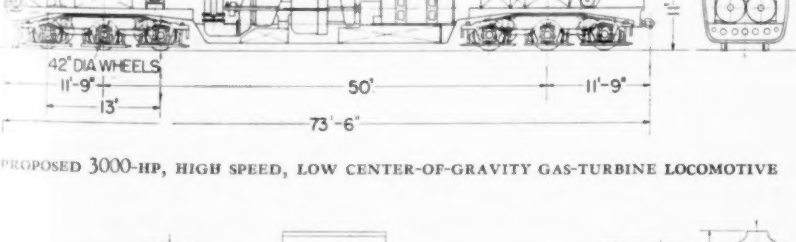
The gas turbine is equipped with a regenerator and at full load of 4200 shp, 70 F atmospheric temperature, and 1300 F gas temperature, should reach a fuel-to-gear input efficiency of 24 per cent.

The locomotive will be designed for the following principal data: maximum speed, 110 mph; tractive effort, one hour, 62,000 lb at 17 mph; tractive effort, continuous, 51,000 lb at 22.5 mph; and tractive effort, starting, 127,000 lb up to 4.5 mph.

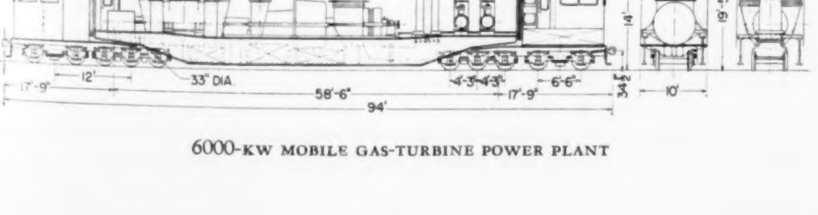
The application of a gas turbine to a high-speed locomotive having an unusually low center of gravity is described. The proposed locomotive would be equipped with a 3000-hp oil-burning gas turbine with electric transmission and would be capable of speeds up to 140 mph. This locomotive represents a unit having its center of gravity only 4 ft above the head of the rails. This is from $1^1/_2$ to 2 ft less than that of presently used high-speed Diesel-electric locomotives and about $2^1/_2$ to 3 ft less than that of modern high-speed steam locomotives.

The 3000-hp high-speed gas-turbine locomotive contains an open-cycle gas turbine. In the case of the coal-burning locomotive, an auxiliary unit containing the coal bunker and the coal-handling equipment would be added. As proposed for oil burning, the locomotive weighs approximately 270,000 lb or 45,000 lb per axle. Two trucks are used, each truck containing two traction motors. The passenger cars would also be of the low-center-of-gravity type.

A 3000-kw and a 6000-kw portable gas-turbine power plant are also described. Such units could be placed on any existing track and deliver power on comparatively short notice.



PROPOSED 3000-HP, HIGH SPEED, LOW CENTER-OF-GRAVITY GAS-TURBINE LOCOMOTIVE



6000-KW MOBILE GAS-TURBINE POWER PLANT

Freight-Car Construction

Opportunities in Freight-Car Design, by S. M. Felton, American Railway Car Institute, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-128** (mimeographed).

It is pointed out that the national fleet of 1,764,000 freight cars includes 369,000 over 30 years old, 178,000 from 26 to 30 years old, and 436,000 between 21 and 24 years old.

Estimates as to the actual number of freight cars that will be needed vary. The minimum is fixed at 14,000 cars monthly—more if possible—in the recent Harriman report to the President. That means at least 168,000 new cars a year. In the national resources and foreign-aid report of the Interior Department, the domestic requirement is placed at a minimum of 180,000 cars yearly through each of the next five years. In any event, about 1,000,000 freight cars will have to be replaced within the next five or ten years.

New freight cars should be highly susceptible to mass production, with specifications written so as to encourage volume purchasing and volume use.

In making new cars, present thinking should be guided and disciplined by these six questions:

1 What can we do to eliminate or at least reduce prepackaging requirements?

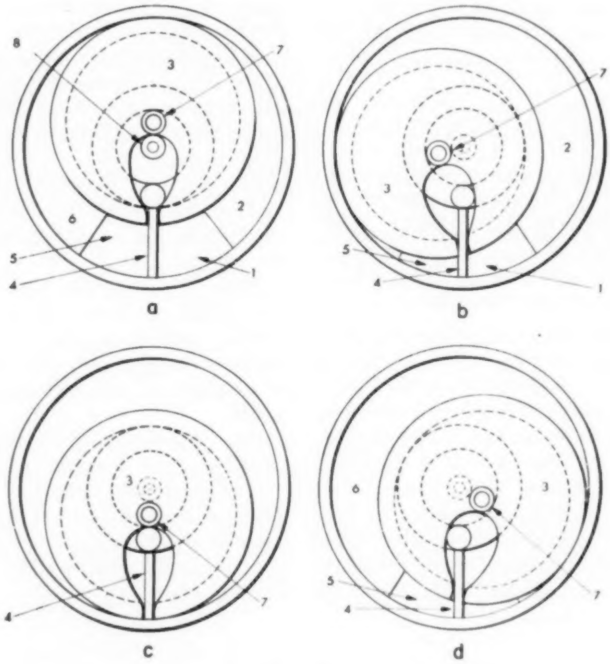
2 What can we do to eliminate or reduce loss and damage claims?

3 What can we do to pare down costs incident to the rehandling and restowing of freight?

4 What can we do to reduce the amount of unproductive dead weight in the freight car?

5 What can we do to reduce freight-car maintenance charges?

6 What can we do to reduce the initial and over-all costs of freight-car ownership?



ACTION OF OSCILLATING-PISTON CHAMBER

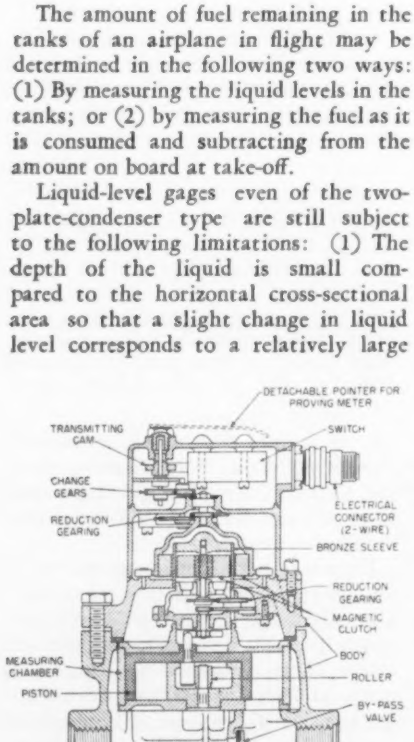
[(1) Inlet port, (2) incoming liquid space, (3) piston, (4) diaphragm, (5) outlet port, (6) outgoing liquid space, (7) piston spindle, (8) control roller.]

Fluid Meters

Oscillating-Piston Meters for Fuel Consumption in Aircraft, by C. S. Hazard, Mem. ASME, Neptune Meter Company, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-54** (mimeographed).

The amount of fuel remaining in the tanks of an airplane in flight may be determined in the following two ways: (1) By measuring the liquid levels in the tanks; or (2) by measuring the fuel as it is consumed and subtracting from the amount on board at take-off.

Liquid-level gages even of the two-plate-condenser type are still subject to the following limitations: (1) The depth of the liquid is small compared to the horizontal cross-sectional area so that a slight change in liquid level corresponds to a relatively large volume change; (2) the gallonage reported may vary with flight attitude; (3) the capacity may be altered by temporary displacement of fuel cell walls; and (4) when a large number of fuel tanks are used, the installation becomes complicated.



CROSS SECTION OF OSCILLATING-PISTON FUEL METER FOR AIRCRAFT

In order to increase accuracy, engineers of the major airlines reasoned that the best way to measure volume would be to use a volumetric meter. The oscillating-piston type of displacement meter was developed on this basis. A true piston motion is secured by oscillating a circular-shaped piston so that it continuously maintains contact with both the inner and outer walls of a chamber.

The measuring element drives a transmitting cam through reduction gearing. This cam closes a switch once for each gallon, actuating a three-digit solenoid counter on the instrument panel of the airplane.

This type of meter is suitable for rates of flow between 20 and 1200 gph. Within this range, the volumetric throughput will register within a tolerance of plus and minus 0.2 per cent. The guaranteed tolerance, however, is plus and minus 1 per cent to allow for the following factors: (1) The difference in viscosity between regular jet fuel and gasoline; (2) changes in viscosity of the fuel due to temperature; (3) compressibility of the liquid; (4) the increments of adjustment of the calibrating means, and (5) residual errors in calibration.

It is pointed out that this method of measurement does not take account of fuel lost by leakage. It is also a fact that operating personnel would prefer to know their fuel consumption in mass units, rather than in volume units, since engine thrust is more nearly proportional to the mass of fuel consumed. Nevertheless, against the small errors arising from the use of volumetric readings must be balanced the simplicity, reliability, and lightweight of the oscillating-piston meter.

High-Pressure Gas Measurement, by E. E. Stovall, Lone Star Gas Co., Dallas, Texas. 1947 ASME Annual Meeting paper No. **47—A-62** (mimeographed).

A discussion of available data obtained through research and operating practices with reference to the measurement of natural gas by orifice meter at pressures in excess of 500 psig is presented. The phases discussed are research work, operating practices, measuring installations, determination of physical characteristics, use of present data, and equipment for use in determination of needed data.

Problems encountered with respect to determination of the compressibility, specific gravity, and measurement of wet

gases, and means employed to cope with these problems are presented.

The significance of the factors used in measurement calculations at high pressure are discussed. Graphs and sketches showing pertinent data, measuring stations, and pulsation absorbers are included. The correlation of data obtained from both research and practice by those engaged in this work, and published in a practical form for industry use, is suggested.

New basic orifice coefficients and other factors which make possible a wider use of orifice meters are given.

Accurate Wide-Range Metering of Natural Gas With the Differential-Type Meter, by L. K. Spink, Mem. ASME, The Foxboro Company, Foxboro, Mass. 1948 ASME Spring Meeting paper No. **48—S-1** (mimeographed).

The differential type of flowmeter has many characteristics which are desirable for measuring large volumes of gas, but has two important limitations when applied to the measurement of widely varying flows. Because the rate of flow bears a square-root relationship to differential, an accurate reading of widely varying flows cannot be obtained from an average value of the differentials. This is so because the square root of the average differential is not the same as the average square roots. The second limitation is the problem of obtaining readability of low flows without overranging at high flows.

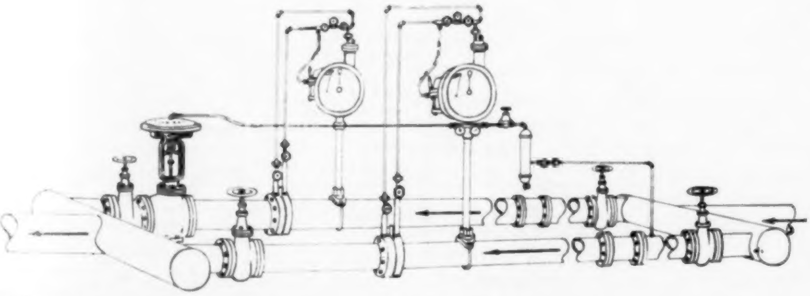
The rate of response of the mechanical method of extracting the square root is not the same at high flows as it is at low flows; therefore a uniform flow-scale type of meter which extracts and records the square root of a differential cannot be damped to read an accurate average of rapidly fluctuating flow. Accurate operation of such a meter is limited to flows changing slowly enough for the instrument to follow them with reasonable fidelity.

By mechanically damping the meter mechanism, some of the fluctuation can be averaged out. For instance, a fluctuation of differential amounting to as much as 60 per cent of the operating differential can be averaged out with an error of less than 2 per cent.

The paper discusses several methods of reducing fluctuations. The first, which is not always practicable, is the substitution of a full throttling automatic control mechanism for "on-off" control. If the duration of zero-flow periods are known, fair results may be obtained by averaging the top of the record and multiplying the computed flow by the ratio of the actual flow time to the total time. Another method lies in the use of cushioning capacity between the meter and the point of consumption. Use of an extremely fast meter equipped with automatic integrator is also mentioned.

The problem of readability at low flows also stems from the square-root relationship between flow and differential. Several devices for increasing readability are discussed. By mechanical means, the spacing at the lower readings on the chart can be spread out and the readings at the outside of the chart narrowed down. This solution is questionable, however, because of the inherent complexity of the mechanism necessary and the difficulty of maintaining calibration. Use of multiple-meter runs, although an obvious method, presents difficulties unless the change-over is made automatic so that sudden and unpredictable peak-load changes will not be lost during the interval before the change-over is completed. The differential relief valve developed to make change-over automatic and the automatic differential limit controller which helps to increase rangeability from a minimum number of meter runs, are discussed.

The disadvantages of the differential-type flowmeter are more than counterbalanced by such desirable features as simplicity, accuracy, freedom from wear, ease of checking, low cost, and flexibility of flow range.



MULTIPLE METER RUN INSTALLATION USING DIFFERENTIAL LIMIT CONTROLLER FOR AUTOMATIC OPERATION

Management

User Research as a Tool in Developing New Industrial Products, by Ernst E. Wachsmuth, James O. Peck Company, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-64** (mimeographed).

Stated simply, a new product is one which the manufacturer has not previously made, regardless of whether or not it resembles in principle or functions something already available on the market. Because it is a basic departure, it poses new problems of design, engineering, fabrication, and marketing.

Today, most product research and development is carried on with the clear realization of the fact that its ultimate purpose is to create a salable product.

Ideas leading to the development of new products may reach the manufacturer from many channels and sources, i.e., contacts with inventors, own engineering department, or via the sales department. Regardless of the source, careful study and consideration are required before the designer draws the first line on paper. Is it salable? What price? What is the competition? How large is the market? In what fields?

It is usually a decided advantage if the new product can be made with available equipment, if the manufacturer capitalizes on available technical skill and experience, and if the product is marketed through established sales organizations to fields in which recognition and acceptance are already enjoyed.

To the manufacturer, a new product represents an investment which must be amortized out of profits. The willingness of a buyer to pay for the product depends on the degree to which it contributes toward the solution of a practical problem.

One of the important services that user research can render is to help find ideas for new products. Turn to the customer and study carefully how he can be helped to do a job more effectively, at lower cost and with reduced effort. On-the-spot observation can anticipate coming needs long before the customer calls for the product.

It is pointed out that conceiving, developing, and designing your own new products offer great advantages. With user research your own engineering staff is called upon to provide the solutions. There are less outside interferences, less need for royalties, and no obligation to work with an inventor who does not fit in. And, most important, if the idea for the new product springs from the needs of the market itself—you are sure to manufacture a product that will sell.

Joint Training Course in Labor Relations Conducted by a Textile Mill and a Union, by Gen. Irving J. Phillipson, Botany Mills, Inc., Passaic, N. J. 1947 ASME Annual Meeting paper No. **47—A-84** (mimeographed).

This paper presents in detail the circumstances surrounding a Joint Training Course in Labor Relations conducted by Botany Mills, Inc., and the Textile Workers Union of America, CIO. The inception of the plan, the preliminaries incident to initiating the course, the contents of the course, the methods of instruction and the procedures incident to it, the description of graduation exercises, and general conclusions are presented.

The undertaking is unique in that there was complete integration of effort between the company and the union from the preparation of the lessons to the presentation of diplomas.

The contents of the course, in general, included the following: Objectives and indoctrination; general personnel policies; foundations of good relations; four-step method; grievance procedures; memorandum of agreement; and general review and test.

Some of the objectives were as follows: To promote a better understanding of the employer-employee relationship; to impress all with the community of interest and responsibilities; to become better acquainted with one another; and to provide a uniform procedure for dealing with problems and differences.

Modern Quality Control, by S. Collier, Johns-Manville Corporation, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-111** (mimeographed).

Quality control means the efforts that are part of a plan set by a company to insure that the quality of the goods being shipped to a customer meets established standards.

Today, as mass production has become general, the tendency has been away from pride of workmanship (where the individual was actually his own inspector) and the need of inspection as a separate operation has become necessary.

Customer acceptance of goods now is becoming very critical. Mutual confidence with customers has been built up by reviewing with them the statistical control data accumulated. This resulted not only in their becoming interested, but also enabled agreements on specifications to be reached. The use of statistics is not new, but it is not being utilized enough.

The use of a training motion picture was found to be an unequaled method in putting across new ideas to production managers, supervisors, industrial engineers, and inspection personnel. The objective was to sell statistical quality control. It sometimes takes as long as two years to bring to a successful conclusion a carefully formulated program for quality control.

Diesel-Fuel Exhaust

The Removal of Aldehydes From Diesel Exhaust Gas, by R. F. Davis and M. A. Elliott, Office of Synthetic Liquid Fuels, Central Experiment Station, Bureau of Mines, Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-108** (mimeographed)

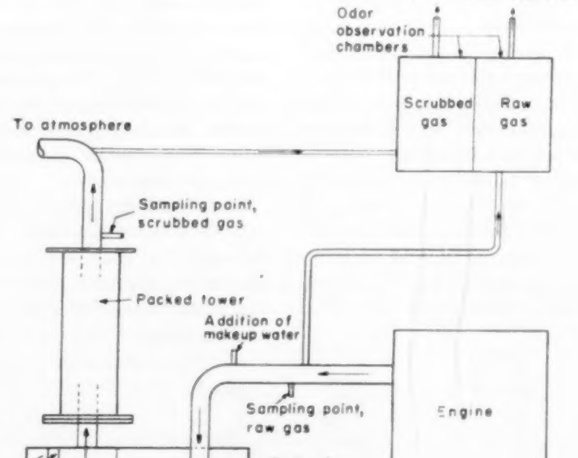
This report presents the results of the following studies: (1) To determine the relation between aldehyde content of Diesel exhaust gas and the odorous and irritating properties of that gas; and (2) to determine the effectiveness of different scrubbing media for removing aldehydes from Diesel exhaust gas.

Observations on the odor and irritation produced by Diesel exhaust gas have shown that both of these properties can be correlated with the concentration of aldehydes in the exhaust gas. The threshold concentration for perception of odor is approximately 0.2 to 0.3 ppm of aldehydes (expressed as equivalent formaldehyde). The threshold of nasal and eye irritation occurs at about 1 ppm of aldehydes (expressed as equivalent formaldehyde).

A series of full-scale tests in the removal of aldehydes by scrubbing with water showed that as the concentration of aldehydes in the scrubbing solution increases, the percentage removal of aldehydes decreases. At elevated temperatures, the removal was nil and under no conditions was complete removal obtained.

From a series of laboratory tests it appeared that an aqueous solution of sodium sulphite might be used in removing aldehydes from Diesel exhaust gas if hydroquinone was added to inhibit the oxidation of sodium sulphite. A full-scale test showed that an aqueous scrubbing solution, containing 10 per cent sodium sulphite by weight and 0.5 per cent hydroquinone, removed substantially all aldehydes for a period of seven hours and 90 per cent or more of the aldehydes for a period of 15 hr. In this test approximately 3000 cu ft of dry exhaust gas (at 60 F and 29.92 in. Hg) was scrubbed per hour at a scrubbing temperature of 133 F.

Numerous estimates of the cost of scrubbing Diesel exhaust gas indicate that the cost of materials would be approximately 80 cents for an engine operating continuously for eight hours and producing an average of 5000 cu ft of dry ex-



SCHEMATIC REPRESENTATION OF SCRUBBING SYSTEM FOR REMOVING ALDEHYDES FROM DIESEL EXHAUST GAS

haust gas (at 60 F and 29.92 in. Hg) per hr.

Problems Associated With Use of Diesle Fuels, by W. L. H. Doyle, Mem. ASME. and E. W. Landen, Caterpillar Tractor Company, Peoria, Ill. 1947 ASME Annual Meeting paper No. **47—A-124** (mimeographed).

This paper presents results of recent investigations dealing with the nature of exhaust products resulting from the combustion of Diesel fuels, particularly those products composing smoke.

These findings, together with knowledge gained from the extensive research work in the field of combustion demonstrate the significant influence of chemical composition and physical properties of Diesel fuels on engine combustion. Engine power outputs, reliability, and durability are also affected.

This is related to some of the properties used for defining the various classes of Diesel fuels with the object of emphasizing factors which appear to need further development.

It is suggested that new standardized tests be evolved, one whereby the relative stability can be determined and another whereby the "Diesel-fuel combustibility" quality can be evaluated. Suitable inspection limits could be used for specifications.

New additive-type lubricating oils must be made available for use in the medium- and higher-speed Diesels to combat the deleterious effects of sulphur contents in the fuels for these engines.

Production Engineering

A Discussion of Modern Quality Control Techniques, by C. W. Kennedy, Federal Products Corporation, Providence, R. I. 1947 ASME Annual Meeting paper No. **47—A-65** (mimeographed).

This country, by using "efficiency experts," has been able to get more and more conveniences and luxuries (more in the form of civilized living) for less and less effort and money. However, some unpleasant conditions grew out of this. One was a decline in pride of workmanship, and the other a general slackening in quality standards.

Hence, perhaps as a natural consequence, the recent war nurtured another industrial technique—not efficiency this time, but quality control. We had discovered how to make things fast and cheap; now we set about making them well.

Just what is quality control and why should it interest an engineer? Splitting it up, quality should be thought of strictly as a characteristic or property or an existing condition, whether good or bad, while control is used in the sense of a standard of comparison.

Broadly, statistical quality control is divided in two classes of direct effort: By attributes, where a flat determination is made that one piece, part, component, or unit is defective and another is not; by variables, where methods and analyses deal with the variations between similar pieces, operations, or units.

The "characteristic" is what we are looking for, those elements which produce conformance.

In manufacturing, statistical quality control is ordinarily associated with inspection, and this in turn depends almost entirely on sampling. Here is where the uninitiated can go astray. By means of sampling tables, formulas, examples, and detailed discussions the author clears up this common pitfall.

Quality control is obtained from using sampling tables by reporting back speedily to the production area responsible the extent of those lots that fail to meet the sampling restrictions so that corrective action can be taken as soon as possible. They can also be used to check purchased parts and materials.

Sampling procedures and tables have paid off in plant savings and product reliability as well as preventing misjudgment on the part of the inspector.

Everywhere possible quality control uses charts. A chart depicts the conditions of a job at a glance. It has a "psychological" effect on the worker, stresses the competition and rivalry among operators and between shifts, all of which exerts a salutary effect on the plant's product reliability and scrap report. An interesting side light is that, after a chart system is adequately installed, production almost without exception automatically increases about 10 per cent.

Quality control involves three general lines of effort. First there is the systematic collection and recording of accurate data. Frequently the record is graphic, as in the case of charts. The next step includes a logical arrangement of the information and intelligent interpretation of it. Finally, a practical engineering or executive action must be taken when the information indicates an unsatisfactory condition.

The action part should be emphasized. Without it all the statistical effort is in vain. Inspections and statistics cannot make the product any better than it is. Omit the action and there is *no control* of quality.

A Recent Development in Automatic Lathe Control, by E. P. Bullard, 3rd., Mem. ASME, The Bullard Company, Bridgeport, Conn. 1947 ASME Annual Meeting paper No. **47—A-131** (mimeographed).

The three-spindle automatic lathe was developed to meet the need for an automatic machine capable of automatically performing, with a minimum of special tooling, the large variety of turning operations normally performed on a standard engine lathe.

It was recognized that the design of a conventional engine lathe permits using one tool to turn an unlimited number of diameters and shoulder lengths, at various speeds and feeds, and where necessary to take two or more cuts on the same diameter in order to remove excessive stock.

Previous automatic lathes usually perform a very simplified sequence of predetermined functions, necessitating the simultaneous use of a number of tools in order to produce the part to the required specifications. Under these conditions, it is often impossible for each tool to operate at its most advantageous speed and feed, and the forces imposed upon the work considerably impair the accuracy of the finished part.

The operation of the three-spindle automatic lathe is identical to that of the engine lathe inasmuch as the Man-Au-Trol unit which controls operation of the machine permits the tool or tools to perform any sequence of functions necessary to produce the part in question. Consequently the three-spindle lathe is capable of performing turning operations in a manner exactly similar to that used on a conventional engine lathe, but with the advantage that three parts are done simultaneously and the operation of the machine is entirely automatic.

A Clinical Approach to Weldment Design, by Gerald von Stroh, Lukens Steel Company, Coatesville, Pa. 1947 ASME Annual Meeting paper No. **47—A-132** (mimeographed).

A clinical approach to the design of weldments is a study of the behavior of welded structures, particularly failures during and after their service life, much in the same manner that a physician approaches a human ailment and learns from it.

Generally, the cost of making full-size experimental stress-analysis studies is prohibitive. Although much work has been done in developing fatigue-testing

machines, the cost of such equipment and its operation is so high as to limit this field to companies producing large quantities of an identical part. Designers must continue to grope, using knowledge of material properties established under ideal conditions.

It seems therefore that careful correlated study of failures is the one remaining way of obtaining data of practical value, a recognition of the fact that a failure is an opportunity to learn something, rather than an occurrence that must be hidden.

The need for such a clinical approach is the result of a combination of features peculiar to weldments such as the frequently overlooked fundamental that a welded structure is one piece of metal and that for economical reasons that one piece of metal may have designed into it internal or external notches and cracks.

The paper analyzes several types of welded fatigue failures which are illustrated with "before and after" pictures.

Heat Transfer

Prediction of Pressure Drop During Forced-Circulation Boiling of Water, by R. C. Martinelli, Jun. ASME, and D. B. Nelson, Jun. ASME, General Electric Company, Schenectady, N. Y. 1947 ASME Annual Meeting paper No. **47—A-113** (mimeographed).

In a number of engineering flow systems it is important to be able to predict the pressure drop occurring during the forced-circulation boiling of water. In most calculations the two phases, water and steam, are considered as a uniform homogeneous mixture with a calculable specific volume and frictional pressure drop. The main difficulty is the estimation of the friction factor.

Several approaches to this problem have been suggested in the technical literature available. This paper combines several of these data references and then extends them in order to establish a new approach, which is, however, tentative and still requires experimental verification.

The new method postulates that the pressure drop resulting from the flow of a boiling mixture is made up of two parts: (1) The pressure drop due to the frictional forces acting during the two-phase flow; and (2) the pressure drop resulting from the rate of increase of momentum of the mixture as it flows through the tube and vaporizes.

A procedure for the rapid calculation of the two pressure drops itemized is established, from which a set of curves are developed. These curves can be employed for a quick estimation if the exit quality, the boiling pressure, and the pressure drop for 100 per cent liquid are known.

The method itself is based on the application of pressure-drop data obtained during the isothermal flow of air and various liquids, to the evaluation of local pressure gradients during forced-circulation boiling.

The proposed method is definitely an extrapolation of existing data and as such requires further experimental verification. Based on a meager amount of data, a comparison of predicted and measured pressure drops with pressures from 18 to 3000 psia, and exit qualities from 4 to 100 per cent, indicates that the method has promise.

Eight curves and a sample calculation are included in the paper.

Shell-Side Heat-Transfer Characteristics of Segmentally Baffled Shell-and-Tube Heat Exchangers, by Townsend Tinker, Mem. ASME, Ross Heater & Manufacturing Company, Buffalo, N. Y. 1947 ASME Annual Meeting paper No. **47—A-130** (mimeographed).

The art of predicting the performance of a baffled shell-and-tube heat exchanger can still be considered as being in the elementary stage. Film characteristics on the tube side have been predictable with acceptable accuracy, but up to now the shell-side coefficient has been uncertain to about plus or minus 50 per cent.

This paper analyzes the fluid-flow pattern on the shell side and develops a new method of evaluating the mass flow through the heat-transfer surface.

Lack of information as to the quantitative effect on the flow pattern of such factors as baffle spacing, tube size, tube pitch, baffle-hole clearance, baffle-to-shell clearance, and tube-bundle-to-shell clearance has been the main stumbling block to shell-side flow evaluation. This method ties leakage, by-pass, and flow characteristics directly to the dimensions and clearances of the exchanger.

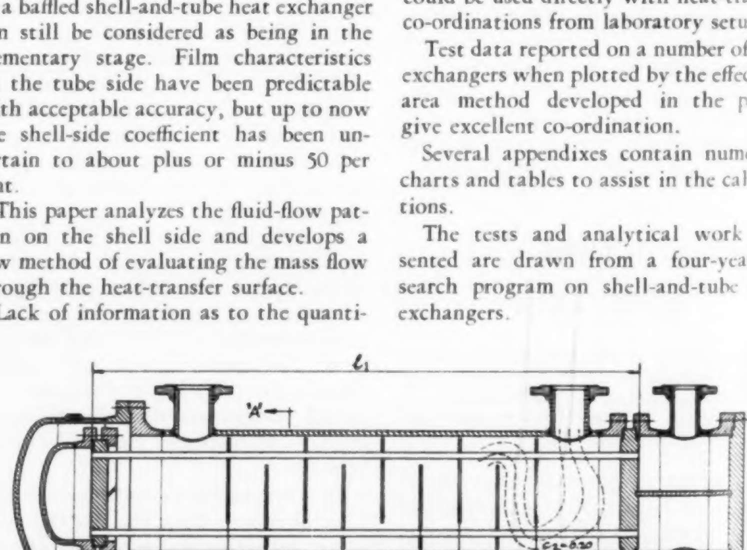
The accompanying illustration shows one of the most widely used exchangers used for heating or cooling a fluid stream, with segmental or "half-moon-type" baffles. The dimensions indicated are some of the most important factors influencing the shell-side fluid-flow pattern and consequently the shell-side heat-transfer coefficient and pressure drop.

In order to improve the predictions of shell-side heat-transfer coefficients, an effective flow area is developed based on the actual dimensions of the heat exchanger and taking into account the approximate magnitude of various flow streams through the shell of the heat exchanger. With the effect of leakage and by-pass incorporated in the effective area, this area will indicate the effective mass velocity of the portion of the fluid stream through the tube nest. Reynolds numbers can then be secured that could be used directly with heat-transfer co-ordinations from laboratory setups.

Test data reported on a number of heat exchangers when plotted by the effective-area method developed in the paper, give excellent co-ordination.

Several appendixes contain numerous charts and tables to assist in the calculations.

The tests and analytical work presented are drawn from a four-year research program on shell-and-tube heat exchangers.



TYPICAL SHELL-AND-TUBE HEAT-EXCHANGER CONSTRUCTION

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Integrated Forest Utilization

COMMENT BY GEORGE M. HUNT[1]

This paper[2] is good reading for anyone who has an interest in the more efficient and profitable utilization of our national timber supply. The operation the author describes is an outstanding example of what can be done by a company that has large timber holdings, the will to manage them on a sustained-yield basis, abundant capital, a competent research organization in which it has faith, the ownership of all its wood-converting facilities, an excellent marketing organization, and a progressive spirit. In fact, the company has everything required for successful and efficient utilization, and, at the operation described, is making the most of its opportunities. Furthermore, the company is not content with its accomplishments to date, but is spending considerable sums on research to effect additional improvements. Hence we may confidently expect further progress in getting higher values from the wood, as well as in increasing the annual growth of timber on their lands. This is cause for congratulation.

While the company mentioned in the paper presents an outstanding example of what can be done to use wood more efficiently, it is fortunate for the country that it is not the only one that is making such progress. Here and there throughout the country, other large timber-holding and conversion companies are increasing the efficiency of their operations and reducing the percentage of their timber crop which finds no use, or brings inadequate returns. Some of these companies are farther ahead than others, some have better opportunites, more favorable location for markets, or better research facilities than others, but progress is being made all along the line that bodes well for the future.

The limitations of the paper did not allow the author to emphasize a fact in which the writer is sure he believes; namely, that much progress in integrated utilization of wood is possible even when the timber and the several conversion plants are not all owned by one company. The obstacles are greater, of course, when several companies are involved, and progress is slower. Such progress is necessary, however, because it is only occasionally that the timber and all conversion facilities are in one ownership. More commonly, the timber available at a given point comes from a number of owners, and each timber-using plan depending upon it is under separate ownership. In other instances, timber and sawmill may belong to one company, but there is no provision for using the low-grade or waste material except as other companies are established for the purpose.

Unfortunately examples of this type of integration are few and far between at present, but there is reason for thinking they will become more numerous in the future. There is an interesting example in the Pacific Northwest which perhaps the author would have mentioned in a fuller treatment of the subject. It consists of a unique working arrangement between an aggressive and resourceful by-product operator and several sawmills scattered over a rather wide area. The by-product operator buys the slabs in the conveyers at the several sawmills, puts in his own machinery and operating personnel, and converts the usable material to specialty products which the parent mills under their plans of operation and selling do not see fit to convert themselves. The key to the apparent success of this approach to integration is that the by-product operator makes a specialty of ferreting out marketing possibilities for cut stock and also in the application of the most efficient mechanical equipment for low-cost handling of the raw material; two factors which it is believed are more basic to improved utilization than we are usually disposed to recognize.

The present great demand for lumber and other wood products, together with the current limited supplyand high prices, offers a great incentive to closer utilization. Opportunities are also offered for the development of new wood products, processes, or the revival of old ones that would not pay under prewar conditions.

All wood research and development organizations concerned with the public interest must increase their efforts to bring about these developments, particularly developments suitable for small-scale operations. Processing plants which cost several millions of dollars can be afforded by relatively few organizations. Under suitable conditions, they provide the greatest efficiency and lowest cost, and they will continue to be built and operated by those who can afford them. For the much larger number of small manufacturers and businessmen, however, the urgent need is for wood products and processes which require investments of only a few thousand dollars up to perhaps a quarter of a million. Processing plants of this size can be adjuncts of moderate-sized woodworking plants now in operation, like the tail on a dog, whereas the million-dollar waste-using plant, in many instances, would be like a tail wagging the dog. We need a great variety of small-scale processes so that the prospective user can select from many possible processes those which best fit his needs and conditions. It is a stimulating challenge to all research and development organizations, as well as to those whose business it is to promote the application of research results to industry.

[1] Director, U. S. Forest Products Laboratory, Madison, Wis.

[2] "Integrated Forest Utilization in the Pacific Northwest," by O. Harry Schrader, Jr., MECHANICAL ENGINEERING, vol. 69, Dec., 1947, pp. 999–1004.

COMMENT BY F. F. WANGAARD[3]

The author has presented a most timely discussion of a development that is receiving widespread recognition among the wood-using industries. There are probably few examples of integrated utilization as complete as that conducted by the grouping of plants described in this paper. Nevertheless, real progress in this direction is being made in all of the timber-producing sections of the nation.

In the southern pine region, sawlogs, pulpwood, poles, crossties, piling, and naval stores constitute a logical combination of products obtainable from these versatile species. Hardwoods such as oak, growing on contiguous areas, yield flooring, lumber for manufactures, and distillation products.

In the northern hardwood region, veneer logs are commonly segregated

[3] School of Forestry, Yale University, New Haven, Conn.

from sawlogs and, in at least one operation, veneer-cutting is so closely integrated with the sawmill that logs from which a suitable veneer bolt can be obtained are cross-cut on the log deck of the sawmill, and the high-grade bolt diverted to the adjoining veneer mill. Low-grade logs are utilized for hardwood distillation to obtain charcoal or, more profitably, chipped to provide raw material for chemical pulping or for the production of Asplund fiber for roofing felt, insulation, and other fiber products.

The possibilities for closer utilization of so-called waste resulting from the conversion of logs to lumber, as indicated in this paper, including salvage of short lengths of clear material suitable for secondary manufacture, sawdust and shavings for briquets or other molded or pressed products, slabs and edgings for pulp chips, and bark for fiber or chemical use are of great interest through out the entire industry in its efforts to find a greater value than plant fuel in such material representing nearly one third of the total log volume.

Industrial Planning

TO THE EDITOR:

The following quotation is taken from a recent article by D. C. Prince:[4]

"In any year the total purchasing power created and available to individuals, business, and government is exactly equal to the value of the goods and services produced over all." Francis A. Walker wrote that the word "measure" should be applied to purchasing power, if at all, in a consciously metaphorical sense. Possibly the author uses the term "purchasing power" as a metaphor for money.

As it stands the statement involves two vagaries from the usual economic vocabulary, "purchasing power" and "value." Probably the author meant that the total transfer of money in exchange with all goods and services produced, distributed, and used or destroyed during a year is the economic measure of those goods and services. If this is not what was meant then his statement has no quantitative significance. To maintain full employment, it is necessary to produce, distribute, and use or destroy goods and services, which latter are destroyed as fast as they are generated, at such a rate that all people who can work are fully engaged in the task of producing, distributing, and destroying goods and services at whatever prices including wages, salaries, and all other payments to individuals for services rendered then hold, and that the total rate of money transfer is great enough for that purpose.

The author wrote, "To maintain full employment, it is necessary that the specific goods and services produced by those which the receivers of the purchasing power wish to buy." If there is no typographical error there the statement is meaningless. Again it is noted that the term "purchasing power" is used as a substitute for the word "money."

The writer wished to add that Jacob Viner described purchasing power as "a treacherous term," and Lipson wrote of it as "illusive, the vague generalizations about which are more misleading than illuminating." So it is, if one stops to think about it, and does not merely accept whatever one reads in economic literature as making sense. As Gustav Cassel wrote, most economic theory consists of "loose and dim concepts, falsely stated problems, confused reasonings, representations not in touch with realities—in fact all sorts of dogmatic rubbish."

BASSETT JONES.[5]

[4] "Long-Range Industrial Planning," by D. C. Prince, MECHANICAL ENGINEERING, vol. 70, Feb., 1948, pp. 137–142.

[5] Mem. ASME.

EDITOR'S NOTE: A typographical error did occur in the quotation cited by the writer. The sentence quoted should read, "To maintain full employment, it is necessary that the specific goods and services produced *be* those which the receivers of the purchasing power wish to buy."

Services to Members

TO THE EDITOR:

Increased personal service by The American Society of Mechanical Engineers to its members is needed if it is to hold its rightful place in the engineering profession. This statement is true of the other founder engineering societies.

The leadership of the founder societies is being challenged by various local engineering societies and by at least one national society. This challenge arises from the more personal service given by such organizations to their members.

The founder engineering societies have combined to give personal employment service through their Engineering Societies Personnel Service, Inc. They could combine also in legal and business matters to serve their members better through the general counsel that is used in common by them.

Engineers have many problems in business and legal matters that often could be answered easily and at negligible expense by an attorney. These problems to the individual engineer are annoying in the time required to dig out the answers. The answers when obtained are applicable to many engineers. They could be made readily available through an attorney who was delegated to serve the members of the founder societies.

Typical problems are as follows:

1 Type of contract for engineering services that is desirable when doing professional work in foreign countries.

2 Recommended contracts for domestic engineering services such as have been provided by the American Institute of Architects for architects.

3 Relationships between engineers and their employers on patents.

4 Data on restrictive laws as to the practice of professional engineering in various states. Referring an engineer to the digest of such laws published by the National Council of State Boards of Engineering Examiners is inadequate. Copy of such digest is not quickly available to engineers outside the principal cities. The answer to any broad question in licensing can only be obtained by reading the digest for all states—a time consuming job that could be better handled once by an attorney for the founder societies. His answer could then be used in answering similar questions from other members.

5 Relations with labor unions.

6 Recommended standard fees for professional services and their possible violation of antitrust laws. Note the recent suit against the National Association of Real-Estate Brokers by the U. S. Attorney General.

Every engineer will have little dif-

ficulty in adding to the preceding suggestive list from his experience.

The mutual insurance companies will review without charge the insurance carried by an individual in order to advise him where coverage is inadequate. A list of securities will be similarly reviewed by an investment house without cost. Farmers have their co-operative associations for the sale of agricultural products. Labor unions take a direct interest in the welfare of any member and will argue his case with his employer.

The founder engineering societies at best will refer an engineer with a legal or business problem to a book in the library or reply they do not know the answer. The answer when obtained is often simple but hours can be spent in finding it. The better procedure would be to refer the inquiring engineer to an attorney employed by the founder societies. This attorney would rapidly build up the answers to a list of recurring questions. If his willingness to answer such questions were known, considerable use of his services would undoubtedly be made. And the founder societies would really be serving their members instead of being essentially debating societies for the advancement of technical knowledge.

GREGORY M. DEXTER.[6]

[6] Mem. ASME.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, ASME, 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the Cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of February 20, 1948, and approved by the Council on March 22, 1948.

CASE No. 1066

(Interpretation of Par. P-183)

Inquiry: The Power Boiler Code makes no reference to the length of flanges required for the heads of fire-tube boilers that are backed into the shells and fillet welded or the length of flanges at furnace end connections. Is it permissible to use the rules in Par. P-183 but reduce the flange length in consideration of the fact that this requirement applies to riveted construction?

Reply: It is the opinion of the Committee that the intent of the Code will be met if the flanges of backed-in heads and furnace end connections to be fillet welded meet with the requirements of Par. P-106 for the flanges of dished heads concave to pressure.

CASE No. 1067

(Special Ruling)

Inquiry: May ferrous and nonferrous tubular products not identified as complying with an approved Code specification be used in the construction of boilers and unfired pressure vessels if it can be demonstrated either by presenting acceptable authentic test reports or by conducting chemical and physical tests that the material does have properties within the permissible range of an approved Code specification?

Reply: It is the opinion of the Committee that seamless or welded tubes or pipe not completely identified with any approved Code specification may be used in the construction of boilers and unfired pressure vessels under the following conditions:

(1) If an authentic test record for each heat or heat-treating lot of material is available, proving it to have properties within the permissible range of an approved SA or SB specification.

(2) If an authentic test record is not available, or all of the material cannot be positively identified with the test record by legible stamping or marking, each length of tube or pipe shall be subjected to a chemical check analysis and sufficient physical tests to satisfy the authorized inspector that all of the material is properly identified with a given heat or heat-treatment lot, and that the chemical and physical requirements of the approved Code specification are complied with. Material specified as suitable for fusion welding, cold bending, close coiling, etc., shall be given sufficient check tests to satisfy the inspector that each length of material is suitable for the fabrication procedure to be used.

(3) If the test requirements of the approved Code specification are more restrictive than the specification or authentic tests that have been reported for the material, such more restrictive tests shall be made in accordance with the requirements of the approved specification and the results submitted to the authorized inspector for his approval.

(4) Each length of tube or pipe shall be gaged for thickness in accordance with the requirements of the approved specification. For tubes, such gaging shall be on the basis of minimum wall.

(5) After such material has been properly identified with an approved specification and the authorized inspector has been satisfied that the material complies with such specification in all respects, the testing agency shall stencil or otherwise mark as permitted by the applicable material specification, a serial "S" number on each length, or as alternately provided for small sizes in the specification, in the presence of the inspector.

(6) Suitable report forms, clearly marked as being a "Report on Tests of Non-Identified Material" shall be furnished by the boiler or pressure-vessel manufacturer or testing agency, properly filled out, certified by the testing agency, and approved by the inspector.

(7) The authorized inspector shall have the right to accept or reject the testing agency or the test results.

(8) The requirements for fabrication applicable to the specification to which the nonidentified material corresponds shall be followed and the allowable design stress shall be that given in Tables U-2, U-3, or U-4 (P-5, P-6, P-7) for that corresponding specification.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have

been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the Code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-106. Revise to read:

P-106 HEAD FLANGES [Dished Heads]. Dished heads concave to pressure TO BE ATTACHED BY BUTT WELDING, AND BACKED-IN HEADS OR FLANGED FURNACE CONNECTIONS TO BE FILLET WELDED, shall have a length of flange not less than 1 in. for HEADS [shells] not over 24 in. IN EXTERNAL diameter AND NOT LESS THAN $1^1/_2$ IN. FOR HEADS OVER 24 IN. IN DIAMETER. [For shells over 24 in. in diameter this length shall be not less than $1^1/_2$ in.]

PAR. P-112(**a**)(6). Add the words "See Par. P-300 for slip-on flanges."

PAR. P-112(**e**). Revise first sentence to read:

The manufacturer OF BOILER PRESSURE PARTS WELDED UNDER THE PROVISIONS OF THIS PARAGRAPH shall be responsible for the quality of the welding done by his organization and shall conduct tests, etc.

Add a fourth paragraph to read:

The requirements for welding external piping (not a part of the boiler circulation and beyond the outlets of the boiler) as permitted by this paragraph are given in Par. P-116.

PAR. P-116. Add the following new paragraphs:

P-116. All piping external to the boiler installed under the provisions of Par. P-112 shall be installed by a manufacturer or contractor authorized to use any one of the symbols shown in Figs. P-41, P-48, or P-49.

Such piping contractor shall be responsible for the quality of the welding done by his organization and for the qualification of the procedure and of the welding operators used on the work.

The qualification tests of the procedure and the welding operator shall be as required in Section IX.

The qualification tests of a procedure and of welding operators made in accordance with the requirements of Section IX may be accepted by an authorized inspector if certified by the contractor as applying to the stated procedure and by stated welding operators.

An authorized inspector shall have the right at any time to call for and witness tests of the welding procedure and of the welding operator and the tests of the welded specimens, but it is not necessary for the inspector to witness the welding of the test welds or the tests of such welds.

To avoid duplication of qualification tests of procedure or welding operators, it is recommended that procedures and welding operators qualified as required above be acceptable for any similar welding work on piping using the same procedure.

PAR. P-300. Revise first sentence of fifth section to read:

When welded piping that is included by the scope of this Code is fabricated by anyone other than the manufacturer of the boiler, the welding shall be done in accordance with Pars. P-112 and P-116 and by a manufacturer or contractor in possession of one of the Code symbol stamps shown in Figs. P-41, P-48, or P-49 and who has been issued a certificate of authorization.

Add the following to the fifth section:

ASA Standard slip-on flanges, not to exceed 300 lb series, may be attached to piping by double fillet welds provided the throats of the fillet welds are not less than 0.7 times the thickness of the part to which the flange is attached.

SECTION IX. GENERAL. Revise third paragraph to read:

Except when otherwise specified in the Code, each manufacturer or contractor shall be responsible for the quality of the welding done by his organization and shall conduct tests not only of the welding process to determine its suitability, etc.

PARS. P-1 and U-12. Add the following as (**b**):

(**b**) Pressure parts such as pipe fittings, valves, flanges, nozzles, welding necks, welding caps, manhole frames and covers, shall be made of materials listed in Section II of the Code or in an accepted standard (such as ASA) covering the particular type of pressure part. Such parts shall be marked with the name or trademark of the manufacturer and such other markings as required by the several standards. Such marking shall be considered as the manufacturer's guarantee that the product complies with the material specifications and standards indicated and is suitable for service at the rating indicated. The intent of this paragraph will have been met if, in lieu of the detailed marking on the part itself, the parts described herein have been marked in any permanent or temporary manner which will serve to identify the part with the manufacturer's written listing of the particular items and such listing is available for examination by the inspector.

PAR. P-299. Par. P-299(**i**) will be changed from "Copper or brass screwed" to read "Brass or bronze screwed," and (**j**) will be changed from "Bronze valves and fittings" to "Brass or bronze valves and fittings". . . . . . Also, add a section to (**j**) to read:

Brass or bronze screwed fittings complying with ASA B16.15 (1947) 125 lb, class and B16.—(1948) 250 lb class, may be used within Code limitations.

A column will be added to Table A-11 giving the metal thickness of the 125 and 250 lb bronze screwed fittings from the ASA standards. In Par. P-112(**a**)(5) the depth of socket will be changed from $^1/_4$ in. to $^3/_8$ in., and the nominal pipe size will be changed from 4 in. to 3 in. to agree with ASA Standard B16.11.

PAR. U-36(**a**) In the definition for "*E*," omit the words "which is not coincident with a diameter".

PAR. U-201(**d**). Revise second section to read:

The hammer test as specified in Par. U-77(**b**) shall be made under a hydrostatic pressure of not less than $1^1/_4$ times but not more than 1.6 times the maximum allowable working pressure. Following the hammer test, the vessels shall be hydrostatically tested to not less than 1.6 times the maximum allowable working pressure, for a sufficient length of time to permit an inspection of all joints and connections.

MATERIAL SPECIFICATIONS: The following specifications will be revised to make them identical with the latest A.S.T.M. Specifications indicated: SA-157 (A 157-44); SA-158 (A 158-47T); SA-193 (A 193-47); SA-206 (A 206-47T); SA-216 (A 216-47T); SA-217 (A 217-47T); SA-266 (A 266-47); SA-280 (A 280-47T).

TABLE Q-5 A reference to Specifications SA-300, SA-301 and SA-302 will be listed under "P" Number 4—"O" Number 1.

TABLES P-7 AND U-2. Include reference to SA-300 in Table U-2, and add the following footnote to this table:

The stresses to be used for temperatures below −20 F when made in conformance with SA-300 shall be those given in the column −20 to 650 F.

Add the following stresses:

Temperature, Deg F

	−20 to 650	700	750	800	850
SA-301	14000	14000	14000	13500	12000
	900	950	1000	1050	1100
SA-301	10200	8000	5000	...	...
	−20 to 650	700	750	800	850
SA-302	15000	15000	15000	14400	12700
	900	950	1000	1050	1100
SA-302	10400	8000	5000	...	...
	−20 to 650	700	750	800	850
SA-299	15000	14100	12400	10100	7800
	900	950	1000	1050	1100
SA-299	5600	3800	20002	...	...
	−20 to 650	700	750	800	850
SA-217, WC5	15000	15000	15000	14000	12500
	900	950	1000	1050	1100
SA-217, WC5	10200	8250	6250	...	...
	−20 to 650	700	750	800	850
SA-217, WC9	12000	12000	12000	11800	11200
	900	950	1000	1050	1100
SA-217, WC9	10000	8250	6250	4800	3700

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Modern Organic Finishes

Modern Organic Finishes—Their Application to Industrial Products. By R. H. Wampler. Chemical Publishing Co., Inc., New York, 1946. Cloth, $5^1/_2 \times 8^1/_2$ in., 452 pp., illus., $8.50.

Reviewed by M. E. Hodges[1]

ANYONE connected with the handling, purchasing, or supervision of organic finishes in industry will find this book to be invaluable. The author has presented a thorough outline of practical commercial methods of preparing surfaces for finishing, applying organic protective and decorative finishes, methods of drying, and their application.

In section 1, chapter 1, the author treats the formulation of characteristics and various uses of oleoresinous and alkyd varnishes and enamels; chapter 2 treats similarly, cellulose lacquers, spirit varnishes, high-integrity and special finishes; and chapter 3 covers stains, wood and metal fillers, and miscellaneous finishing materials. Anyone having a finishing problem of selecting the correct material for his particular type of work should have little trouble after reading this section.

Section 2 covers modern application methods. There are five chapters on this subject, each chapter covering a different method of application: Chapter 4, spray painting; chapter 5, dipping and flocoating; chapter 6, roller and knife coating; chapter 7, tumble and centrifugal finishing; and chapter 8, special processes. Here again, anyone handling or interested in finishing would do well to read this section and might find that many short cuts and improvements could be made in their present application methods.

Section 3 consists of three chapters on drying methods: Chapter 9, air drying; chapter 10, force drying; and chapter 11, baking by convection and radiant heat; and high frequency baking. Here the author has given a very comprehensive outline of practically all types of drying.

Section 4, chapter 12 on product handling in the finishing department covers conveying methods from tote pans to the latest type of automatic conveyers.

Section 5 on finishing processes, consists of eleven chapters on the complete method of finishing from the original preparation of surfaces to the final drying of many types of products such as wood furniture, plywood, paper, fabrics, plastics, automotive, sheet steel, iron castings, and aircraft. Considerable attention is also given to the final rubbing and polishing of organic finishes.

The last section consists of two chapters, one on good practice in the finishing department and the other on testing and evaluating finishes. The first of these chapters covers many subjects pertaining to good practice in a finishing department, such as the proper handling and storage of materials, containers, the proper mixing and thinning of finishes, cleanliness in the finishing department, fire hazards and their prevention and safety. The last chapter covers various methods of testing and evaluating finishes. Here the author gives a good outline of various testing procedures and evaluating their results.

This book contains a good index and could be used to a good advantage by anyone interested in finishing as a reference book.

[1] Plant and Process Engineer, Electrolux Corporation, Old Greenwich, Conn.

Personnel Administration

A Point of View and a Method

Personnel Administration: A Point of View and a Method. By Paul Pigors and Charles A. Myers. McGraw-Hill Book Company, Inc., New York, N. Y., 1947. Cloth, $6 \times 8^7/_8$ in., 553 pp., $4.50.

Reviewed by John R. Bangs[2]

TO all thinking members of management and certainly to all sincere men engaged in the field of industrial relations and personnel administration the authors, Messrs. Paul Pigors and Charles A. Myers, have struck at the very heart of the subject when they say, "There is no greater challenge than the opportunity to bring out the best in a free people working in an organization so that they will genuinely enjoy their work and thus enable the organization to accomplish its purpose."

In their work entitled "Personnel Administration" the authors point out that today as never before industry has come to realize that it has lacked foresight when it failed to recognize that machines without men are useless. That in order to keep men to operate machines they must be studied and carefully handled to produce the best operating results.

For years engineers and manufacturing executives have readily agreed that a preventive maintenance program is the soundest basis upon which to keep production flowing steadily, and to keep the cost of mechanical repair at a minimum. But few have recognized the fact that a parallel and synonymous program of good industrial relations is the least expensive way to keep men on the machines and all other employees at their highest level of efficiency.

Lately realization of this past neglect of the human factor has brought about a great deal of serious consideration by industrial leaders, to the point where personnel policies are the recognized daily concern of top management, with the net result that the personnel administrator has been brought to the level of a valued member of the president's operating staff.

As the authors state, "Today personnel administration is not a separate part of management, to be considered apart from the problems of product design, production, accounting, or sales. Rather it is a basic management function, permeating all levels and types of management. Good management gets results with the co-operation of other people, and this is personnel administration."

At the outset it must be agreed that the first step in an effective personnel program is the establishment of the position of the major personnel officer as that of one who has the confidence of the president of the company and who

[2] General Manager of Industrial and Personnel Relations, The Budd Company, Philadelphia, Pa. Mem. ASME.

reports directly to that president. This person then sees to it that there is a "continuous co-ordination of the personnel department with the line organization." Unless such a situation can be created from the very beginning the personnel administrator's best efforts will be fruitless.

"Situational thinking" is the key to the personnel administrator's function. This key he will find himself using daily, for in the true position of adviser he must keep himself out of the limelight as much as possible and yet he must see to it that the weight of his decisions carry through to all levels. He must combine logic with a keen sense of observation. He must be able to demand respect by the application of good leadership. Respect not only for himself as an individual but for the company policies which he must interpret in detail.

By the habitual use of "situational thinking" the personnel administrator will sidestep many a pitfall in his dealings not only with top management, but with the staff and line members of the management group and the individual members of the working force, together with their union representatives. By placing himself in the position of others and groups of others he can by comparative analysis, the application of his knowledge of organizational structure, and the fluent interpretation of policies, sift the wheat from the chaff and thus open the road to better understanding of hidden factors, be they grievance of employee, poor practice on the part of executives and managers, or the cumbersome application of unnecessary red tape.

Basically the authors have prepared in "Personnel Administration" a text which can be used by those interested in the field of personnel administration to help themselves to become practitioners of "situational thinking," and a sound investment will it be, for not only does this book clearly define personnel administration but it treats in detail on almost every function of the whole subject of personnel administration and the practice of good labor relations.

For clarity and the ready handling of such a broad subject the book is divided into two parts, the first of which treats with (*a*) The nature of personnel administration, (*b*) handling personnel problems, (*c*) diagnosing organizational stability, (*d*) building and maintaining work teams, (*e*) wages and hours, (*f*) employee services and programs and the conclusion which is the personnel point of view.

Part Two consists of case illustrations. Through their new and unique use of the case method of study the authors are to be congratulated on the way in which they have graphically presented nineteen examples of actual recorded cases of industrial labor problems. These are used to illustrate the theories propounded in the various chapters of the book together with a series of pertinent questions concerning each case, which when closely studied automatically bring the reader to the realization of the value of "situational thinking."

Mutual Survival

MUTUAL SURVIVAL—The Goal of Unions and Management. By E. Wight Bakke. Harper & Brothers, New York, N. Y., 1947. Cloth, $5^1/_2 \times 8^1/_4$ in., 82 pp., \$1.50.

REVIEWED BY FREDERICK S. BLACKALL, jr.[3]

THE eminent Charles M. Bakewell, lately Professor of Philosophy at Yale, whose searching mind stirred the beginnings of intellectual curiosity in this reviewer many years since, used to open his freshman course in the History of Philosophy with these words: "Gentlemen, if you learn nothing else from this course, I trust you will glean this much: that you are never qualified to disagree with another until you have thoroughly grasped the other's point of view."

If mutual understanding between management and labor is the sine qua non of a workable entente between them, Mr. Bakke's little volume should be required reading for negotiators on both sides of the table. As Director of Yale's Labor and Management Center, the author is in an exceptionally favorable position to sound the views of typical industrialists on the one hand, and typical leaders of the labor movement on the other. He sets forth his findings in this book word for word, and line for line, in what becomes a fascinating parallel of opinion.

Bakke makes no attempt to sermonize or judge between the parties. Indeed much of his book constitutes simple reporting. Sixty of its 82 pages comprise a catalog of replies which he has received or the verbatim transcript of conferences held with sixty outstanding representatives of management and a like number of leaders of organized labor in nine major centers of industrial activity in the East and Middle West. "These representatives had been recommended as persons of broad interest and experience with collective bargaining, who were thoughtful about that experience," says the author, and in sampling their opinions he has, to use his own phrase, "tapped all shades of reaction from that which was specifically antagonistic to that which was unusually co-operative." Thus Mr. Bakke's book has been written in considerable measure by these labor and management leaders themselves, supplemented only by commentary and analysis, without any effort to determine the ethics or logic of either cause. Neither are any solutions offered for reconciling opposing convictions. The attempt merely is to present each side's problems, position, and convictions so that each will know what it is up against in dealing with the other.

As so often is the case with disputants, each appears convinced that any compromise with principles encourages a threat to his own survival. The pot continually calls the kettle black. But in digesting this inventory of allegation and opinion, the reader inevitably distills out of it a better understanding of the areas in which a constructive rapprochement is possible—those areas in which compromise, now on one side, now on the other, can lead to agreement and mutually constructive effort.

It is more important in resolving these problems that each know why the other behaves as he does than to philosophize about how the other ought to behave. Mr. Bakke's opus stems from a deep-seated conviction that until such an understanding comes about, there can be no permanent labor peace. A pragmatist, he is convinced only that nothing is right which will not work and that a clearer understanding by each party of the other's objectives and fundamental points of resistance is the essential lubricant for the mechanism of give and take which is the heart of the collective bargaining process. A clear comprehension of the other fellow's point of view should assist at least in avoidance of those positions which are bound to lead to industrial strife. If Mr. Bakke's premise is right, and I think it is, this volume provides an invaluable tool to this end. In one of the few conclusions which he draws from the welter of opinion and counteropinion, he finds that both union and management leaders have the same sort of objectives, the survival of free unions on the one hand, the survival of free management on the other. Failure to work out the means of *mutual*

[3] President and Treasurer, The Taft-Peirce Manufacturing Company, Woonsocket, R. I. Member and Director, ASME.

survival will not be the elimination of one by the other, but the elimination of both as free institutions by public regimentation.

This volume should prove a genuine aid to improved labor relations and more enlightened collective-bargaining procedures.

Combustion Engineering

COMBUSTION ENGINEERING. Edited by Otto de Lorenzi. Combustion Engineering Company, Inc., New York, N. Y., 1948. Cloth, 6 × 9 in., 1025 pp., figs., and tables, $7.50.

REVIEWED BY A. G. CHRISTIE[4]

THE principal controllable element in the production of steam is the economical combustion of fuel. Information on the design and operation of equipment which will produce optimum results with available fuels is highly desirable. American manufacturers have in the past met this demand by the issue of such books among others as "Helios," by Heine Safety Boiler Company; "Steam," by The Babcock and Wilcox Company; and "Finding and Stopping Waste in Boiler Rooms," by Cochrane Corporation. Each of these proved a valuable addition to this literature.

Its thirty-one chapters and over a thousand pages present logical and well-organized statements by men experienced and well qualified in the design and operation of fuel-burning and steam-generating equipment. The book thus becomes an authoritative source of information on the equipment, planning, and operation of American boiler rooms.

A comprehensive review of the many chapters is impossible in this short discussion. These deal in a specific manner with fuels and their combustion; stokers of all types; pulverized-coal equipment; the combustion of oil, gas, wood, and waste fuels; furnace construction, together with steam purifiers; superheaters, economizers, and air heaters; feedwater and its treatment; test codes and performance calculations; draft equipment; the use of instruments; the operation and maintenance of combustion equipment; special applications; and the Company's practices in boiler construction.

The text is easily followed and the discussions are readily understood. Many portions have particular value and deserve particular mention. The book stresses the reducing action of fuel beds and the need of overfire air with stokers. Much attention is devoted to the design of furnaces for the various types of stokers and helpful information is presented on arch construction, heat release, and ash disposal for the several types of stokers and other furnaces.

The place of such heat-recovery equipment as economizers and air heaters is discussed effectively. An excellent chapter which will be helpful to many engineers deals with the selection of equipment. The author quite properly emphasizes the importance of instruments and their use in the boiler room. The section on operation and maintenance will be closely studied by operating engineers, as its recommendations are specific and definite. Appendixes give information on coal resources, steam properties, and other data.

While the illustrations naturally cover products and installations of the sponsor company, the editor has on the whole, avoided publicity propaganda and has restricted statements to discussions of best current practice. The book is one of the most comprehensive of its kind. It will interest both the practicing engineer and the technical student, each of whom will find its contents of high value.

[4] Past-President and Honorary Member ASME, Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md.

The Strange Story of the Quantum

THE STRANGE STORY OF THE QUANTUM, By Banesh Hoffman. Harper & Brothers, New York, N. Y., 1947. Cloth, $5^1/_2$ × 8 in., 239 pp., $3.

REVIEWED BY I. I. RABI[5]

IN a day when physics is making such giant strides that even the release of atomic energy is an almost subsidiary event, it is astonishing that quantum mechanics is not better known at least to that part of the educated public which concerns itself with scientific matters. Yet quantum mechanics furnishes the guiding principles and the intellectual structure within which physicists have worked for more than twenty years. It is the bright beam which has lit the pathway to most of the recent discoveries. The quantum symbolized by Planck's constant h is at the bottom of the forces which hold atoms together to form molecules, crystals, or any solid, and which determine their properties. It governs the nature of nuclear forces, the rates of chemical reactions, the electrical conductivity of metals. With the exception of gravitational attraction, there is practically no observable phenomenon which does not lead back to the quantum.

In a certain sense it is understandable that the properties of the quantum are not very widely known. Like relativity it started with rather abstract and mathematical notions. Although these difficulties are now largely overcome, yet a fairly close knowledge of classical mechanics and electrodynamics is required for mastery of the subject. On the other hand the principles of quantum mechanics represent such a radical departure from the classical point of view as to appear almost bizarre. In a sense a long acquaintance with classical ideas almost unfits one to grasp and accept the revolutionary new ideas. Strange as the quantum may appear, it has one irresistible recommendation. It fits the hard facts of experiment. These ideas are corroborated in the most exact quantitative detail. Quantum mechanics has been able to predict properties of matter which had not been previously even suspected.

It is therefore very timely and fortunate that Dr. Hoffmann has been able to write a most clear and masterful exposition of the fundamental ideas of quantum mechanics. Practically without the use of any mathematics it leads the reader gently and persuasively through the whole story of the quantum. There is no important point on which he does not touch, and it is rather a *tour de force* that he can make so mathematical and abstract a subject so clear with such simple symbols as laundry lists and violin strings.

Of course much of this simplicity and clarity is illusory because ultimately the whole of the mathematical formalism is necessary for the solution of a definite problem. Nevertheless it is possible to study much more ambitious treatises and fail to get at the fundamentals as well as in this little book of 239 pages.

Dr. Hoffmann starts his story with Planck's original proposal or discovery, which came in the first year of this century. The further development of the quantum idea by Einstein and later by Bohr brings him through almost the first third of the book. The rest is devoted to the heroic period of the quantum mechanics from 1924 to 1932. These wonderful years are described with great spirit and dramatic overtones. It is a success story with the most profound implications.

[5] Professor, Faculties of Political Science, Philosophy, and Pure Science, Columbia University, New York, N. Y.

Quantum mechanics denies the possibility of fulfilling what has always been considered as the minimum program of the physical sciences, i.e., to give a space time, instant to instant, description of physical events in the framework of exact causality. Exact astronomical predictions of the eclipses and motions of the planets notwithstanding, it is impossible to make such predictions with unlimited accuracy. The astronomical predictions are statistical results of a very high but limited precision. When we come to the world of atoms, electrons, molecules, and nuclei, then the classical view breaks down completely in so far as quantitative detail is concerned. A shadowy resemblance to classical ideas still exists in atomic phenomena. Because of this some limited progress was possible even before the advent of quantum mechanics. The reality shows this resemblance to have been to a considerable degree fortuitous.

Those who wish an introduction to these stimulating ideas will find Dr. Hoffmann's book most helpful and illuminating. His audience should go far beyond even the large scientific fraternity.

Engineering Societies Yearbook

THE ENGINEERING SOCIETIES YEARBOOK, 1948. Harry B. Coffin, Editor. The American Society of Mechanical Engineers, New York, N. Y., 1948. Paper, $8^1/_2 \times 11$ in., 95 pp., $3.

REVIEWED BY SAMUEL J. BERARD[6]

THIS initial edition of the Engineering Societies Yearbook, 1948, sponsored by the EJC and published by the ASME, is the first of a planned series of reference books designed to give detailed information on engineering societies, clubs, and councils in the United States and Canada. The information has been compiled from data supplied by 83 national engineering organizations; 174 state, regional, and local clubs, councils, and societies; 35 Canadian engineering societies; 8 international engineering associations; 13 engineering employee organizations; and 5 engineering joint bodies—318 organizations covering practically every branch of engineering and affiliated activity.

The purpose of the Yearbook is to provide engineers, libraries, officers, and staff members of engineering organizations, state, and government agencies, and the like, with full information regarding the purposes, aims, policies, and activities, of each organization, and to serve as a means of facilitating contacts and furthering interests of common concern. The data cover each society, club, and organization, arranged in logical order, including such items as: Name and office address of society, with corresponding abbreviation, name of state and city, affiliated organizations and societies, facilities and type of organization, times and places of meetings, grades, and other features of membership interest, committees, publications, and other information. Included also are statements of aims, purposes, and activities, and such special interests as student scholarships, loans, and awards. This gives a general idea of the coverage in each entry. A perusal of the entries reveals a wealth of ideas and helpful aids concerned with worth-while activities carried on by these organizations in promoting the public welfare by co-operation with civic and other agencies, as well as the maintenance and promotion of engineering interests.

The Yearbook is divided into eight parts, six of which cover complete lists of societies, organizations, associations, and clubs; the other two (parts 6 and 8) give general information and addresses of registration boards for the licensing of professional engineers; and a list of the 134 accredited engineering curricula of engineering colleges and institutions as approved by the ECPD. The six parts covering societies and organizations are: (1) International engineering organizations; (2) engineering joint bodies in the United States; (3) national engineering organizations, including a tabulated chart of student branches of 23 national societies in the accredited institutions; (4) state, regional, and local engineering clubs, councils, and societies; (5) engineering employee organizations; and (7) Canadian engineering societies.

The foreword includes a list of abbreviations with the name of each society, which, in view of the established custom of abbreviation usage in modern technical publications, is important. An interesting graph showing the phenomenal growth of membership of the seven societies composing the ECPD, is convincing evidence (reading between the lines of the graph) of the vital role engineering and affiliated interests have played in making the United States the leading nation of the world. A full-page map locates the engineering societies distributed over the United States and Canada, and a double-page map shows the locations of local sections or chapters of the eight engineering organizations (seven in the United States and one in Canada) which compose the ECPD.

This concise and comprehensive collection of data covering such a wide range of engineering activity, is a valuable contribution to the engineering world and will go far in maintaining and strengthening closer relations among the numerous engineering and allied agencies whose aims and purposes are mutual. It has 95 pages, is attractively bound with flexible covers in the convenient $8^1/_2 \times 11$ size for handy reference, and can be easily slipped into the brief case when planning a trip likely to include places where engineering societies and clubs are located which one might like to visit. A complete index of all societies, reprints of "Canons of Ethics for Engineers" and "Faith of the Engineer," and a list of ECPD publications are included.

The editor, Harry B. Coffin, and his associates are to be congratulated in making available this important reference book. It fills a long-felt want.

[6] Professor Emeritus, Division of Engineering, Brown University Providence, R. I. Mem. ASME.

Books Received in Library

RUBBER RED BOOK, Directory of the Rubber Industry, 1947 edition, sixth issue. Published by *Rubber Age*, New York, N. Y. Cloth, $6 \times 9^1/_4$ in., 835 pp., illus., $5. As a directory of the rubber industry, this book, now in its sixth edition, contains the expected material on rubber manufacturers in the United States and Canada, with classified sections on rubber machinery, equipment, accessories, chemicals, fabrics, and textiles. Consulting technologists are listed as well as natural-, synthetic-, and reclaimed-rubber manufacturers. There is a section on rubber latex, lists of technical trade journals, trade and technical institutions, and a "Who's Who" in the rubber industry.

WORK AND EFFORT, the Psychology of Production. By T. A. Ryan. Ronald Press Co., New York, N. Y., 1947. Cloth, $6 \times 9^1/_2$ in., 323 pp., diagrams, charts, tables, $4.50. This book provides a systematic survey of psychological investigation concerned with productivity. Among the problems treated are training and learning, the control of accidents, establishment of pay levels for various jobs, and the design of efficient methods of work. Motivation of the worker is considered in its relation to problems of efficiency. Conclusions from research in various fields are presented.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

ASME NEWS

And Notes on Other Engineering Societies

Compiled and Edited by A. F. Bochenek

Wisconsin Centennial Celebrations to Be Part of ASME 1948 Semi-Annual Meeting, Milwaukee, Wis., May 30–June 5

Industrial Expositions and Varied Program Planned

MEMBERS who attended the 1947 Annual Meeting Banquet found on each table a "standing" invitation to visit Milwaukee, and to participate in the ASME 1948 Semi-Annual Meeting to be held at the Hotel Schroeder, Milwaukee, Wis., May 31–June 5, 1948. The invitation was a cool bottle of Milwaukee's famous product and while it was more the work of the artist than of the engineer, it comes back as the harbinger of the kind of hospitality that would set the tone of the meeting in June.

There should be no disappointments in the program planned by the ASME Milwaukee Section, for the imagination that inspired the gesture at Atlantic City is everywhere evident in the Semi-Annual Meeting program. It is an engineering event skillfully weighted in the things which make an engineer happy—technical sessions, symposiums, night-club tours, Rathskeller parties, and inspection trips to some of the great plants of American industry. Yet the program has more of interest without being crammed, an entertaining cultural program for the wives of members and guests, a cruise of the city's industrial waterfront, and as part of the centennial celebrations of the State of Wisconsin, a University of Wisconsin Day, and the Wisconsin Industrial Exposition. Excellent planning by the committees of the Milwaukee Section and program-making agencies in the Society has created in the Semi-Annual Meeting program an introduction to the industrial and cultural life of Milwaukee and to the open secrets of its fame.

28 Technical Sessions

The technical program of 28 sessions at which more than 75 papers will be read, includes three important symposiums. The first on Tuesday afternoon is on the subject of anti-icing. Four papers on various aspects of the problem will be presented by representatives of research laboratories, the Air Force, and aircraft manufacturers. Prepared discussions will be read by four representatives of airline operators.

On Thursday morning a symposium on design and standardization of splines sponsored by the Machine Design Division will hear four papers by engineers in the machine-tool and automotive industries.

The effects of trends in coal quality and availability on boiler design will be the subject of the third symposium scheduled for Thursday morning. No formal papers will be presented but four discussers will be prepared to present the point of view of coal producers and boiler- and combustion-equipment manufacturers.

The American Rocket Society, which is an affiliate of the ASME, will sponsor one session on Tuesday, June 1. ARS papers will cover design and fabrication of lightweight pressure vessels for rocket power plants.

Preprints

At time of going to press preprints are available for more than 34 Semi-Annual Meeting papers. These are indicated by the preprint symbol which appears in the tentative program on the following pages.

In accordance with the new scheme for distribution of preprints, members are urged to purchase copies of papers to be presented at sessions they plan to attend before they go to the session room. No papers will be distributed at the sessions, but desks will be set up in the headquarters hotel to make purchase of preprints convenient. Single copies sell for 25 cents to members and 50 cents to nonmembers. For convenience in purchasing preprints, coupon books will be on sale at $2 for 10 coupons to members and $4 to nonmembers. Members are urged to look over the display of other ASME publications.

Preprints currently available may be ordered in advance of the meeting from ASME Publication-Sales Department, 29 West 39th St., New York, N. Y. Orders received one week before the meeting, however, will not be filled until after the staff returns to New York.

THE ASME 1948 SEMI-ANNUAL MEETING WILL BE ONE OF THE FEATURES OF THE CENTENNIAL CELEBRATIONS OF THE STATE OF WISCONSIN

Registration Fee for Nonmembers

THERE will be a registration fee of $5 for nonmembers attending the 1948 Semi-Annual Meeting. The fee will be the same for attendance at one or all sessions except that no fee will be charged for events on Friday, June 4, University of Wisconsin Day, which will be sponsored jointly by the ASME and the University of Wisconsin.

Guest-attendance cards have been discontinued.

Nonmember authors and discussers, immediate family of members, and nonmember students serving as aids will not be required to pay a registration fee.

Open House at Milwaukee Plants

For those who want to see at firsthand the unsurpassed manufacturing facilities centered about Milwaukee, the technical program is spiced with inspection trips to the plants of some of the giants of American industry. The ASME Milwaukee Section has carefully organized each trip to provide maximum convenience and benefit to visiting members. Inspection groups will be divided into small parties, each provided with a qualified guide to answer questions.

Tuesday morning a visit will be made to the Kearney and Trecker Corporation's plant and in the afternoon a group will leave for the plant of the Nordberg Manufacturing Company. On Wednesday morning a trip is scheduled to the Falk Corporation, manufacturers of gears. On Wednesday afternoon another inspection party will leave for the A. O. Smith Corporation where the manufacture of pipe and heavy machinery will be seen.

To avoid overemphasis on the engineering achievements of Milwaukee, a tour of a different kind has been planned for Wednesday evening. Following the banquet, members will be invited to tour the night clubs of the city, during which they will have the opportunity to compare the might and vigor of industrial Milwaukee by day with the charm and hospitality of her leisure hours:

Thursday morning, back again to the business of engineering, members will have an opportunity to cruise about the excellent industrial waterfront of Milwaukee, one of the city's great assets. In the afternoon a party will leave for the Allis-Chalmers Manufacturing Company's plant. On Wednesday evening, members will be guests of the Pabst Brewery at a rathskeller party during which the ancient art of brewing beer will be the subject of interest.

The inspection-trip program will wind up with a visit to the Port Washington Power Plant on Friday afternoon, and on Saturday morning to the Milwaukee Road Shops currently operating at capacity to relieve the world shortage of railroad rolling stock.

University of Wisconsin Day

Friday, June 4, has been designated as University of Wisconsin Day at the Semi-Annual Meeting. As part of the centennial celebrations of the State of Wisconsin, the program has been arranged calling attention to some of the engineering achievements of Wisconsin engineers. At a morning session sponsored jointly by the ASME Fuels and Power Divisions and the University of Wisconsin, some of the pioneering work done in Milwaukee in the use of pulverized coal for high-pressure steam generation will be reviewed, and the present state of the art will be summarized. A general luncheon and visit to the Port Washington power plant are also part of the program.

The climax of the centennial celebrations will be a dinner at which Julius Krug, Secretary of the Interior, and an alumnus of the University, will be the principal speaker. On the program with Secretary Krug will be O. A. Rennebohm, Governor of Wisconsin, and Edwin B. Fred, president of the University.

Cultural Tours on Women's Program

The Milwaukee Section of the Woman's Auxiliary to the ASME extends a hearty welcome to the wives of ASME members and guests to come to Milwaukee and has arranged an entertaining program of sight-seeing tours and social events which will make the Semi-Annual Meeting an event not quickly forgotten.

On Monday afternoon, following a tour of the building of the Engineer's Society of Milwaukee, a talk has been scheduled by Miss Gretchen Colnik on "The Woman's Point of View." On Tuesday morning there will be a tour to Holy Hill in the Moraine district of Wisconsin. Here a panoramic view of the surrounding countryside will be enjoyed. After lunch at the Fox and Hound Inn, where antiques, paintings, and fine old glassware will be seen, the women will return to the headquarters hotel for a cocktail party. The feature of the Wednesday program will be a tour of the Charles Allis Art Library, famous for its collections of oriental ceramics. On Thursday there will be a tour to the Schlitz Brewery.

Make Reservations Early

The hotel situation in Milwaukee is the most favorable in several years. In addition to the sizable block of rooms reserved for ASME members at the headquarters hotel, three other hotels in the immediate neighborhood of the Schroeder Hotel are prepared to honor ASME requests for reservations. Members are urged to make reservations early for the choicest rooms. Prices for rooms are as follows:

Hotel Schroeder	$3.75 to $12
Plankinton House	$3.50 to $9
Pfister Hotel	$3.50 to $10
Astor Hotel	$4 to $9

The Tentative Program

MONDAY, May 31

9:30 a.m.

Opening of Engineering Exposition

2:30 p.m.

Materials Handling

Material Handling Through the Air, by Frank M. Blum, manager, crane sales division, Harnischfeger Corporation, Milwaukee, Wis.

YOUR HOSTS AT THE ASME 1948 SEMI-ANNUAL MEETNG IN MILWAUKEE, WIS.

(*Standing, left to right:* Robert Miller, entertainment chairman; Arnold Ehlinger, women's program; John Bunce, assistant program co-ordinator; Donald Naulin, exhibits chairman; James Van Vleet, assistant banquet chairman; Joseph Olsen, assistant service chairman; Theodore Eserkaln, honorary chairman; Ernest Hartford, executive assistant secretary ASME; Ben Elliott, head of mechanical engineering, University of Wisconsin; and A. Warren Colwell, publicity chairman. *Seated, left to right:* George Miniberger, finance chairman; Ernest Szekely, reception chairman, La Rue Stark, assistant chairman women's program; George Suchy, service chairman; Joseph Drinka, inspection trips; Theodore Wetzel, convention general chairman; and Glenn Eddy of the ASME, Chicago headquarters.)

Solving Mechanical Design Problems of Long Center High Lift Slope Belt Conveyer in the Mining Field, by Bernard G. Schneider, conveyer engineer, Chain Belt Company, Milwaukee, Wis.

Materials Handling—Today's Challenge to the Engineering Profession, by J. Walter Snavely, assistant to manager, conveyer and process equipment division, Chain Belt Company, Milwaukee, Wis.

Mechanical Foundry Material Handling, by George Zabel, Fairbanks Morse Company, Beloit, Wis.

Engineers Civic Responsibility

Professional Licensure, by William H. Larkin, Mem. ASME, president, New York State Society of Professional Engineers, New York, N. Y.

Engineers Civic Responsibility, by David Larkin, Life Mem. ASME, vice-president and general manager, Broderick and Bascom Rope Company, St. Louis, Mo.

TUESDAY, JUNE 1

9:30 a.m.

Gas Turbine Power (I)—Power (I)

Introductory Remarks, by J. T. Rettaliata, Mem. ASME, director, mechanical engineering department, Illinois Institute of Technology, Chicago, Ill.

Gas Turbine Power Plants for Operation With Low-Cost Fuel, by John Goldsbury, Mem. ASME, mechanical engineer, turbine engineering division, General Electric Company, West Lynn, Mass.

The Gas Turbine With a Waste-Heat Boiler, by G. R. Fusner, Jun. ASME, gas turbine engineering division, General Electric Company, Schenectady, N. Y. (48—SA-13)[1]

American Rocket Society

The Design of Lightweight Corrosion-Resistant Pressure Vessels for Rocket Power Plants, by C. C. Ross, Jun. ASME, mechanical engineer, and R. B. Young, Aerojet Engineering Corporation, Azusa, Calif.

Design and Fabrication of Welded High-Strength Pressure Vessels, by J. J. Chyle, director of welding high-strength research, and H. W. Brock, manager, ordnance section, A. O. Smith Corporation, Milwaukee, Wis.

Hydraulic (I)

Performance Criteria for Positive Displacement Pumps and Fluid Motors, by Warren E. Wilson, Mem. ASME, director of research, Hydraulic Division, Sundstrand Machine Tool Company, Rockford, Ill. (48—SA-14)[1]

Machine Design (I)—Railroad (I)

The Association of American Railroads Standard Car Coupler, by H. L. Spence, Mem. ASME, assistant engineer, National Malleable and Steel Castings Company, Cleveland, Ohio. (48—SA-4)

[1] Preprint order number. Preprints will be on sale at the Meeting. Copies may be ordered prior to the Meeting from ASME Publication-Sales Department, 29 West 39th St., New York 18, N. Y.

May ASME News High Lights

Something for everyone is the keynote of the Milwaukee Semi-Annual Meeting program. Preprints of 30 papers are now available. Look over the program and order papers before you go to Milwaukee (471–476).

At its National Conference in St. Louis, the Oil and Gas Power Division will review the history and the present status of the Diesel Engine (481).

Success of the Spring Meeting and the quality of the papers are reflected in the report of the Meeting (477).

The Applied Mechanics Division will feature a symposium on flow and fracture of metals at its National Conference in Chicago. All but a few of the papers are in preprint form. Look them over and order early (483).

The ASME California Sections are co-operating in a three-day high-level meeting on heat-transfer and fluid-mechanics problems to be held on the campuses of three universities (489).

An impressive program of papers on the problems of mechanical wear will be presented at conferences to be held at the Massachusetts Institute of Technology in June (481).

Behind the Engineering Progress Show being held this month in Philadelphia, is a story of energy and initiative on the part of Philadelphia junior engineers (490).

The procedure devised by Detroit juniors for the "Personal Development" series of lectures may contain the germ of a good idea for other junior groups (490).

A conference on medical men and engineers held recently at the Mellon Institute, promises more effective co-operation among the professions on common problems (482).

Send in the form on page 485 if you have recently changed your address or your job. A new membership list is planned for publication in the fall.

American engineers will be abroad this summer attending three international congresses (486) and a conference which has been called by three British engineering societies to improve international co-operation among the engineering professions of the democracies (486).

The Navy is looking for engineers to man its expanded research program (484). Opportunities in atomic-energy research are made available by the fellowships offered by the Atomic-Energy Commission through the National Research Council (487). Fellowships in gas technology and hydrodynamics look good too (490).

The May Junior Forum will be the last until October. Attempts to expand the editorial committee will be made during the summer (488).

Events that led to the organization of the ASME Boiler Code Committee will be recalled at a special meeting in Boston, Mass (485).

Boiler Code public hearing in April helped to simplify proposed rules to cover the special case of the lined pressure vessel (485).

Applied Mechanics (I)

Computing Machines

The Present State of Electronic Digital Computing Machines, by H. D. Huskey, head, machine-development laboratory, National Bureau of Standards, Washington, D. C.

Large-Scale Computers, by R. L. Snyder, assistant professor, electrical engineering, University of Pennsylvania, Philadelphia, Pa.

Inspection Trip

Kearney and Trecker Corporation

12:15 p.m.

Nuclear Energy General Luncheon

Toastmaster: George A. Parkinson, commanding officer, Naval Reserve, Milwaukee, Wis.

Speaker: O. C. Simpson, associate director, chemical division, Argonne National Laboratory, Chicago, Ill.

Subject: Some Engineering Problems of Peacetime Atomic-Energy Research

2:00 p.m.

Inspection Trip

Nordberg Manufacturing Company.

2:30 p.m.

Aviation (I)—Heat Transfer (I)

Symposium on Anti-Icing

Icing Research–Accomplishments During the Past Winter, by Ralph J. Hawn, project engineer, Climatic Projects Section, Wright-Patterson Air Force Base, Dayton, Ohio

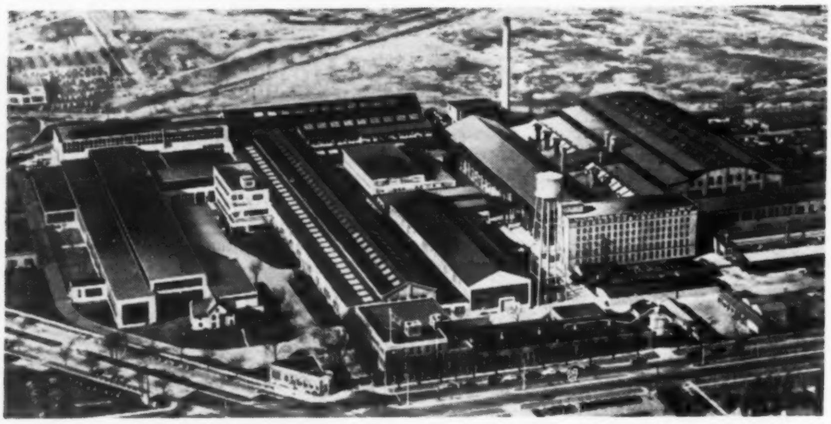
Some Phases of Thermal Anti-Icing Systems, by R. M. Potter, technical director, Aeronautical Ice Research Laboratory, Minneapolis, Minn.

Determination of Heat Requirements for Thermal Anti-Icing Determined by Tests Conducted at the Mt. Washington Laboratory, by T. B. Koebel, supervising project engineer, Aeronautical Ice Research Unit, Mt. Washington, N. H.

What Is an Optimum Anti-Icing Design, by Robert L. Berner and T. H. Grieger, engineering department, The Glenn L. Martin Company, Baltimore, Md.

Service Experience With Heat Anti-Icing, by T. E. Cooper, supervisor of airframe engineering, Northwest Airlines, St. Paul, Minn.

Discussion by: David North, American Airlines; Jack Sheets, propeller division, Curtiss Wright Corporation; W. C. Shaw, United Airlines; C. M. Christensen,



NORDBERG MANUFACTURING COMPANY, MILWAUKEE, WIS., ONE OF THE PLANTS TO BE VISITED DURING THE ASME 1948 SEMI-ANNUAL MEETING

United Airlines; and M. G. Beard, American Airlines

Gas Turbine Power (II)—Railroad (II)

Construction of a Gas Turbine for a Gas Locomotive Power Plant, by W. B. Tucker, Mem. ASME, turbopower development department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Continental and American Gas-Turbine and Compressor Calculation Methods Compared, by Franco Martinuzzi, director of research, Co-Ordination on Gas Turbines, Italian National Research Council, Rome, Italy

2:30 p.m.

Hydraulic (II)

Design of Vaned Turns for a Large Water Tunnel, by J. M. Robertson, associate professor, Pennsylvania State College, State College, Pa., and A. J. Turchetti, Standard Oil Development Company, Elizabeth, N. J. (48—SA-15)

Hydrofoils, by James Daily, Mem. ASME, assistant professor, hydraulics, civil and sanitary engineering department, Massachusetts Institute of Technology, Cambridge, Mass. (48—SA-30)

WEDNESDAY, JUNE 2

9:30 a.m.

Management (I)

Human Relations Can Be Handled Intelligently, by L. B. Murphy, executive vice-president, Williamson Heater Company, Cincinnati, Ohio

Top Executive Action For Better Human Relations, by William S. Ford, William S. Ford, Inc., Milwaukee, Wis.

Ten Months of the Taft-Hartley Act, by E. H. van Delden, director of industrial relations, Libbey-Owens-Ford Glass Company, Toledo, Ohio

Power (II)

Turbine Blade Deposit—Burlington Generating Station, by W. E. Karg, Mem. ASME, superintendent, Burlington Generating Station, Newark, N. J. (48—SA-24)

Prevention of Turbine Blade Deposits, by G. C. Daniels, Fellow ASME, chief mechanical engineer, Commonwealth and Southern Corporation, Jackson, Mich. (48—SA-25)

Reduction of Turbine and Superheater Deposits by Internal Treatment With Magnesium Chloride in Absence of Phosphate, by W. A. Pollock, senior test engineer, power plant, and F. H. Long, test engineer, power plant, Wisconsin Electric Power Company, Milwaukee, Wis. (48—SA-26)

Low Silicon Content of Boiler Water Minimizes Turbine Silica Deposits, by J. N. Ewart, chief mechanical engineer, and T. J. Finnigan, chemical engineer, Buffalo-Niagara Electric Corporation, Buffalo, N. Y.

Education

University-Industry Relations in Developing Engineers, by W. P. Schmitter, chief engineer, The Falk Corporation, Milwaukee, Wis.

Industry Develops Engineers, by Theodore B. Jochem, supervisor, development engineering, Cutler-Hammer, Inc., Milwaukee, Wis.

Milwaukee Plan of Aptitude Testing, by E. C. Koerper, Mem. ASME, research co-ordinator, A. O. Smith Corp., Milwaukee, Wis.

Machine Design (II)

Modern Projection Welding, by R. A. Reich, chief engineer, The Ohio Nut and Bolt Company, Berea, Ohio (48—SA-17)

Transparent Models for the Demonstration and Study of Lubrication Phenomena, by J. Boyd, section manager, lubrication section, research laboratories, Westinghouse Electric Corporation, East Pittsburgh, Pa. (48—SA-31)

The Importance of Cores in Die-Casting Design, by C. R. Maxon, market development division, The New Jersey Zinc Company, New York, N. Y. (48—SA-22)

Inspection Trip

Falk Corporation

12:15 p.m.

Management Luncheon

Presiding: J. Keith Louden, Mem. ASME, Production manager, Glass Closure, Armstrong Cork Company, Lancaster, Pa.

Subject: The Role of Scientific Management in World Recovery

Speaker: C. C. James, associate counselor, Stevenson, Jordan, and Harrison, Inc., New York, N. Y.

2:00 p.m.

Inspection Trip

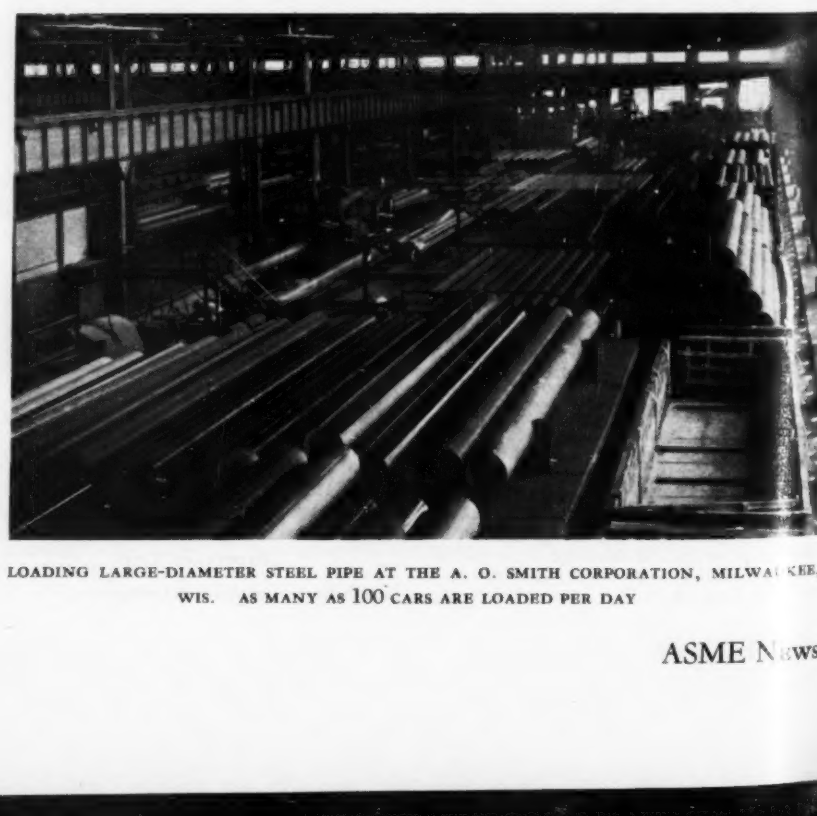
A. O. Smith Corporation

2:30 p.m.

Industrial Instruments and Regulators—Heat Transfer (II)—Aviation (II)

Diagnosing Engine Troubles in Flight, by James W. Wheeler, Jun. ASME, engine instrument engineer, Sperry Gyroscope Company, Inc., Great Neck, N. Y. (48—SA-8)

A Remote Indicating Pressure Gage for Aircraft, by R. G. Jewell, development engi-



LOADING LARGE-DIAMETER STEEL PIPE AT THE A. O. SMITH CORPORATION, MILWAUKEE, WIS. AS MANY AS 100 CARS ARE LOADED PER DAY

neer, General Electric Company, Lynn, Mass. (48—SA-12)

Thermocouple Pyrometers for Gas Turbines, by E. F. Fiock, principal physicist, and A. I. Dahl, physicist, National Bureau of Standards, Washington, D. C.

Metals Engineering—Plastic Flow of Metals—Applied Mechanics (II)

The Flow and Fracture of Metals Under Combined Stresses, by J. H. Holloman, research laboratory, General Electric Company, Schenectady, N. Y.

Drawing Forces for Tubes and Rods, by R. G. Sturm, Mem. ASME, professor, Purdue University, West Lafayette, Ind.

How Forging Acts to Enhance Metal Properties, by E. O. Dixon, Mem. ASME, chief metallurgist and mechanical engineer, and E. J. Foley, both of Ladish Company, Cudahy, Wis.

Management (II)

The New Meaning of Break Points, by Fred V. Gardner, senior partner, Fred V. Gardner and Associates, Milwaukee, Wis.

Establishing Production Standards Without a Stop Watch, by Hugh A. Bogle, group supervisor, management engineering section, E. I. du Pont de Nemours and Company, Wilmington, Del.

Europe Looks to America for Technological Assistance, by John A. Willard, Mem. ASME, partner, Bigelow, Kent, Willard, and Company, New York, N. Y.

Machine Design (III)

Kinematic Considerations of Several Intermittent Variable-Speed Mechanisms, by G. J. Talbourdet, Mem. ASME, engineer, research division, United Shoe Machinery Corporation, Beverly, Mass. (48—SA-18)

A New Approach to the Design of Dynamically Loaded Compression and Extension Springs, by C. I. Johnson, engineer, International Business Machines Corporation, Endicott, N. Y. (48—SA-23)

7:00 p.m.

Banquet

Speaker: To be announced

10:00 p.m.

Milwaukee After Midnight

Night Club Tour

THURSDAY, JUNE 3

9:30 a.m.

Railroad (III)

Thermal Environment of Railroad Passenger Cars, by K. A. Browne, Mem. ASME, research consultant and S. G. Guins, Jun. ASME, project engineer, both of Chesapeake and Ohio Railway Company, Cleveland, Ohio

Visual Passenger Comfort, by Brooks Stevens, industrial designer, Brooks Stevens Associates, Milwaukee, Wis.

Power (III)

Design of Main Cylinder Joints in Steam Turbines, by E. M. Golonka, steam-turbine department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. (48—SA-28)

ASME National Nominations

THE 1948 Nominating Committee invites members to appear at its open meeting May 31, 1948, at the Schroeder Hotel Milwaukee, Wis. Members may present their views concerning candidates for the office of President, Regional Vice-President, and Director at Large any time between the hours of 10 a.m. to 12 noon; and 2 p.m. to 4 p.m.

Steam-Turbine Governor Regulation, by C. E. Kenny, engineer, G. E. Scott, Jr., and C. L. Ringle, Jun. ASME, designer, steam-turbine department, all of Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Applied Mechanics (III)—Aviation (III)—Gas Turbine Power (III)

Centrifugal and Thermal Stresses in Rotating Disks, by W. R. Leopold, Jr., Jun. ASME, design section, Wright Aeronautical Corporation, Woodridge, N. J. (48—SA-1)

Gyroscopic Effects on the Critical Speeds of Flexible Rotors, by R. B. Green, Jun. ASME, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. (48—SA-3)

The Manifold Problem, by J. D. Keller, Mem. ASME, consulting engineer, Pittsburgh, Pa. (48—SA-2)

Machine Design (IV)

Symposium on Design and Standardization of Splines

Straight-Sided Splines, by J. B. Armitage, Fellow ASME, vice-president, charge of engineering, Kearney & Trecker Corporation, Milwaukee, Wis. (48—SA-21)

Involute-Spline Experience, by C. H. Stanard, gear engineer, Buick Motor Division, General Motors Corporation, Flint, Mich. (48—SA-20)

Broach Requirements for Spline Shafts and Fittings, by H. H. Gotberg, chief engineer, Colonial Broach Company, Detroit, Mich. (48—SA-5)

Hobs for Spline Shaft, by Anthony F. Zamis, chief design engineer, Illinois Tool Works, Chicago, Ill. (48—SA-19)

Fuels (I)

Symposium on Effect of Trends in Coal Quality and Availability on Boiler Design

Moderator: E. D. Benton, Mem. ASME, director of research, fuel-engineering division Ohio Coal Association, Cleveland, Ohio

Discussers: E. M. Powell, Jun. ASME, assistant director, engineer, calculating division, Combustion Engineering Company, Inc., New York, N. Y.

J. E. Brunner, Jun. ASME, staff assistant to director of engineering, The Glidden Company, Cleveland, Ohio

V. G. Leach, Mem. ASME, chief combustion engineer, Peabody Coal Company, Chicago, Ill.

E. C. Miller, Mem. ASME, design engineer, Riley Stoker Corporation, Worcester, Mass.

9:30 a.m.

Inspection Trip

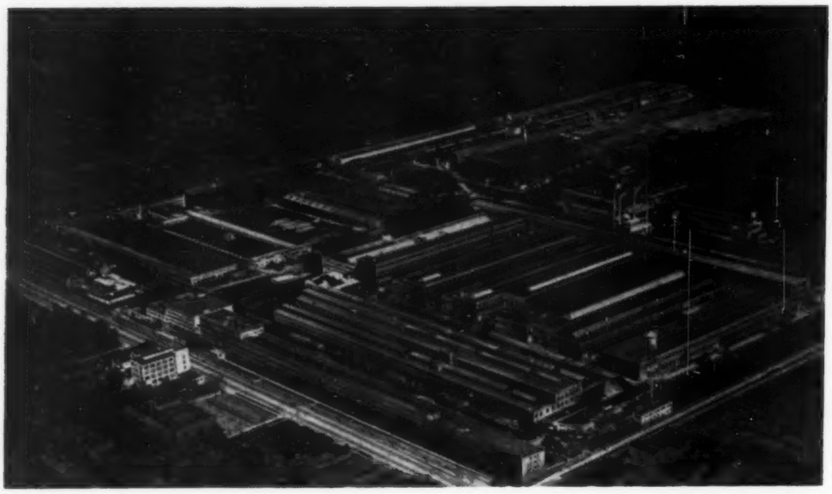
Milwaukee Industrial Waterfront Cruise

2:00 p.m.

Inspection Trip

Allis-Chalmers Manufacturing Company

AERIAL VIEW OF THE PABST MILWAUKEE BREWERY, MILWAUKEE, WIS. A SPECIAL EVENING TOUR OF THE BREWERY WILL BE MADE DURING THE ASME 1948 SEMI-ANNUAL MEETING



WEST ALLIS WORKS OF THE ALLIS-CHALMBERS MANUFACTURING COMPANY, ONE OF THE PLANTS TO BE VISITED BY MEMBERS DURING THE ASME 1948 SEMI-ANNUAL MEETING

2:30 p.m.

Railroad (IV)

Decibel Level, by W. A. Jack, acoustical research consultant, Johns-Manville Company, New York, N. Y.

Truck Riding Comfort, by K. F. Nystrom, Fellow ASME, chief mechanical officer, The Chicago, Milwaukee, St. Paul, and Pacific Railroad, Milwaukee, Wis.

Metal Cutting (I)—Cutting Fluids (I)—Production Engineering (I)

An Evaluation of Cylindrical Grinding Performance, by Commodore R. E. McKee, Naval Base Station, Philadelphia, Pa., O. W. Boston, Fellow ASME, professor and chairman, department of metallurgical processing, college of engineering, University of Michigan, Ann Arbor, Mich., and R. S. Moore, Detroit manager, Quaker Chemical Products Corp., Conshohocken, Pa. (48—SA-9)

Theory and Practice of the Crush Dressing Operation on Grinding Wheels, by Elton C. Helfrich, Jun. ASME, research engineer, The Cincinnati Milling Machine Company, Cincinnati, Ohio

Heat Transfer (III)

Thermal Contact Resistance of Laminated and Machined Joints, by A. W. Brunot, Thomson Laboratory, General Electric Company, Lynn, Mass., and F. F. Buckland, General Engineering & Consulting Laboratory, General Electric Company, Schenectady, N. Y. (48—SA-27)

Thermal Resistance Measurements of Joints Formed Between Stationary Metal Surfaces, by N. D. Weills and E. A. Ryder.

Combustion Studies Using Golay Photothermal Detector With an Infrared Monochromator, by J. T. Agnew, Mem. ASME, research engineer, The Franklin Institute, Philadelphia, Pa. (48—SA-16)

An Extension of Two-Stream Heat-Exchanger Theory to Include the Effect of Longitudinal Conduction, by P. R. Trumpler, Jun. ASME, mechanical engineer, centrifugal-compressor department, Clark Brothers Company, Inc., Olean, N. Y. (48—SA-11)

Machine Design (V)

Design and Manufacture for Profits, by H. B. Osborn, Sr., technical director, Tocco Division, Ohio Crankshaft Company, Cleveland, Ohio (48—SA-33)

Designing for High-Frequency Induction Hardening, by J. T. Temin, commercial engineer, Tocco Division, Ohio Crankshaft Company, Cleveland, Ohio (48—SA-32)

7:00 p.m.

Rathskeller Party

Evening trip through Pabst Brewery

FRIDAY, JUNE 4

9:30

Metal Cutting (II)—Cutting Fluids (II)—Production Engineering (II)

Distribution of Heat Generated in Drilling, by A. O. Schmidt, Mem. ASME, research engineer, charge metal cutting, and J. R. Roubik, Jun. ASME, assistant research engineer, Kearney and Trecker Corporation, Milwaukee, Wis. (48—SA-10)

Progress Report No. 2 on Tool-Chip Inter-Face Temperatures, by K. J. Trigger, Mem. ASME, professor of mechanical engineering, University of Illinois, Urbana, Ill.

9:30

Fuels (II)—University of Wisconsin—Power (IV)

Early Work in Pulverized Coal and High-Pressure Steam Generation at Milwaukee, Wis., by Fred L. Dornbrook, Mem. ASME, chief engineer, power plants, Wisconsin Electric Power Company, Milwaukee, Wis.

Present Status of the Art and Science of Pulverized-Fuel Burning, by B. J. Cross, Mem. ASME, manager, research and development department, and E. M. Powell, Jun. ASME, assistant director, engineering calculating division, both of Combustion Engineering Company, Inc., New York, N. Y.

Fuel Performance at Port Washington Station, by W. A. Pollock, senior test engineer, power plants, Wisconsin Electric Power Company, Milwaukee, Wis. (48—SA-7)

12:15 p.m.

General Luncheon

2:00 p.m.

Inspection Trip

Port Washington Power Plant

7:00 p.m.

University of Wisconsin Dinner

Speakers: Julius Krug, Secretary of the Interior; A. O. Rennebohm, Governor of Wisconsin; and Edwin B. Fred, president, University of Wisconsin.

SATURDAY, JUNE 5

9:30 a.m.

Inspection Trip

Milwaukee Road Shops

THE MILWAUKEE ROAD SHOPS, MILWAUKEE, WIS. THIS PLANT IS CURRENTLY BUILDING MORE ROLLING STOCK PER MONTH THAN THE PULLMAN COMPANY. AN INSPECTION TRIP TO THE PLANT IS SCHEDULED FOR SATURDAY MORNING

ASME New Orleans Section Host to Society at 1948 Spring Meeting

THE ASME New Orleans Section was host to more than 300 engineers and their guests at the 1948 Spring Meeting of The American Society of Mechanical Engineers held at the St. Charles Hotel, New Orleans, La., March 1-4, 1948. The meeting was formally opened at a luncheon at Arnaud's Restaurant at which Alex D. Bailey, past-president ASME, and Paul F. Jahncke of New Orleans, presided. Those attending were addressed by Lyle B. Borst, chairman, Nuclear Reactor Project, Brookhaven National Laboratories, Upton, Long Island, N. Y., who spoke on "The Industrial Application of Nuclear Energy."

Dr. Borst said that for the first time in history, the generation of power from the atom for peacetime use will be demonstrated within the next two years at Brookhaven. Contracts are being negotiated for a steam plant which will derive its power from the nuclear pile planned for further atomic research, with power generated as a by-product.

Because of the excellent coal resources in the United States, Dr. Borst said it is quite possible that atomic power will become economically sound in other countries before it can compete with other sources here.

Atomic Automobiles Not Feasible Today

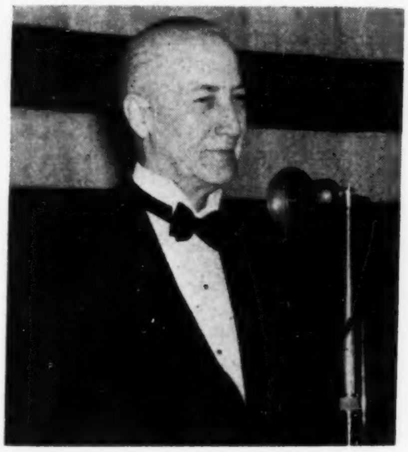
Dr. Borst did not deem atomic automobiles feasible, as at this time the "know-how" to build a safe engine weighing less than about 20 tons does not exist. However, it is highly probable that atomic energy will be used to propel surface ships or submarines, since the utilization of this type of power will tend to eliminate frequent refueling operations.

Calling for industrial support of the Atomic Energy Commission's program for industrial participation, Dr. Borst warned that "bottling up the enterprise behind a solid wall of secrecy, far from fostering, may well jeopardize the nation's security. The bomb and the reactor are products of scientific cross fertilization during the '30s. Unless we have scientific and industrial intercommunication now we will find ourselves, years hence, in a static position—without the industrial background and development that may be our strength in the future.

The development of atomic energy since the war has taken a new direction, focusing attention on beneficial peacetime application. It has reached a point at which widespread industrial technology is possible and is required, if the nation is to maintain its preeminent position and is to benefit to the fullest extent from the new developments of a new field in a new world." Dr. Borst's paper is published in full on pages 295–297 of the April issue of MECHANICAL ENGINEERING.

Semioutdoor Power Plant Visited

On Tuesday afternoon an inspection trip was made to the new Industrial Canal Steam-Electric Generating Station of the New Orleans Public Service, Inc. Visitors were interested in the unique design of the power plant which is of a semioutdoor nature. An



PRESIDENT BAILEY ADDRESSING THE BANQUET

outdoor boiler generates steam at 1350 psi and 955 F for a 37,500-kw 3600-rpm turbo-generating unit situated in a penthouse. Other features are provisions for central control of virtually the entire power plant from an air-conditioned soundproof control room. At the time of the visit, two other units were under construction. The plant will ultimately have a capacity of approximately 115,000 kw.

Another inspection trip was made on Wednesday afternoon to the American Sugar Refinery, one of the largest in the world, where the members witnessed the unloading of raw sugar as well as refining, processing, and packaging operations.

At noon Tuesday, a general luncheon was held at the St. Charles Hotel with James M. Robert, dean of engineering, Tulane University, presiding. At this luncheon a key to the City of New Orleans was presented to E. G. Bailey, president ASME, by A. Baldwin Wood, general superintendent of the New Orleans Sewerage and Water Board. The luncheon was addressed by Prof. Linn Helander, vice-president ASME Region VIII. Professor Helander gave a very comprehensive view of regional activities of the Society in a most constructive address.

The Power to Produce

One of the features of the meeting was the banquet held at the St. Charles Hotel on Wednesday evening at which James M. Todd, Fellow ASME, consulting engineer, New Orleans, La., was toastmaster. The speaker was President Bailey whose subject was "The Engineer and Internationalism."

Mr. Bailey stated that the power to produce was the need of nations for recovery and better living, and the application abroad of the outstanding experience of the United States in the development of the power industry would be a vital force in aiding nations in many parts of the world toward achieving this productive power.

Mr. Bailey warned that technological knowledge and procedures will not suffice "if men do not have the spirit to work together to provide society with the things it needs."

"Why has the power industry made greater progress in the United States than in many other nations?" he asked. "The technical knowledge has been available to engineers everywhere. Is there something in the approach of the engineer in the power industry in this country toward his problems that is responsible for his success? Can this method of approach be applied to other fields and in other nations? May not the engineer's methods of individual initiative and co-operative effort, working effectively toward a common and worth-while goal, be a vital force that is needed in many parts of the world if the best use is to be made of the material aid we hope to give them? Is not the application of this method of approach to problems one of the great contributions the engineer can make to internationalism?"

Engineers Should Serve Majority

In closing, President Bailey stated that "engineers should always freely and co-operatively strive toward the best economic answer regardless of national boundaries, whether operating on land, sea, or in the air.

LYLE B. BORST ADDRESSING THE OPENING LUNCHEON AT THE ASME 1948 SPRING MEETING
(*Left to right:* T. E. Purcell, J. M. Todd, L. B. Borst, Alex D. Bailey, and Paul F. Jahncke.)

L. N. ROWLEY ADDRESSING THE GAS TURBINE POWER SESSION

Engineers should also avoid unsound tradition, personal inhibitions, individual or minority interests, and should seek to serve the majority who are entitled to pay less money for more comforts and achievements, so long as all are willing to co-operate with others, their mutual neighbors."

President Bailey's talk is published in full on pages 399–403 of this issue.

The technical sessions commenced Monday afternoon at the St. Charles Hotel. Under the auspices of the Gas Turbine Power Division, four papers were presented on gas turbines.

In his paper, Mr. Sidler, president, Brown-Boveri, Inc., New York, N. Y., described several European gas-turbine installations and pointed out the factors that influenced the installation of this type of unit. An installation in Peru was also discussed, as well as the performances of a gas-turbine power plant of a 2200-hp locomotive built for the Swiss Federal Railways in 1941. Mr. Sidler stated that airplane superchargers have been built that have operated for several hundred hours with gas-turbine temperatures of 1800 F. However, he stated that at present they are not designing gas turbines for operations over 1200 F until they are convinced that there are metal alloys capable of withstanding temperatures substantially higher.

Gas-Turbine Economics

L. N. Rowley, managing editor, and B. G. A. Skrotzki, associate editor, *Power*, McGraw-Hill Publishing Company, New York, N. Y., discussed the inherent characteristics of gas turbines and comparisons of their economics with that of the steam turbine and the Diesel engine. They made it clear that in the gas turbine we have a prime mover of outstanding versatility already demonstrated by application in virtually all fields, but not fully explored in many. They believe that if the gas turbine is to move ahead as fast as its proponents desire, engineering effort and ingenuity comparable to that now going into technical development must be expended on defining and evaluating the gas turbine's economic possibilities so they may be fully exploited.

John Goldsbury, General Electric Company, Lynn, Mass., discussed the economics and general design requirements of gas-turbine power plants to be operated with low-cost fuel such as natural gas and crude oil in the oil fields, refinery by-products, and by-product gases from industrial processes. Mention was also made of the flow-type turbine power plant with preheated gas, and approximate costs of these flow-type turbine power plants were given. In conclusion, Mr. Goldsbury stated that first cost rather than efficiency should be the primary consideration when a power plant is to be operated with very low-cost fuel. Other comparisons were drawn and observations made of the design and operating conditions inherent to gas turbines.

Performance Versus Cost

S. A. Tucker, until recently managing editor, *Electrical World*, McGraw-Hill Publishing Company, New York, N. Y., called attention to the fact that the gas turbine has only begun the first stages of its advance toward becoming the jack-of-all-trades among prime movers. Specifically illustrative of this fact, in the immediate future gas turbines as power units for railway locomotives would be widely used in America. Even now in aviation the gas turbine can propel a plane faster than any other heat engine. Mr. Tucker pointed out that contrary to the development of the Diesel engine and steam turbine, gas turbines are being tested and proved in the plants of the manufacturer and with the manufacturer's money, men, and facilities. This, he said, very naturally brings about the question as to whether these costs can be absorbed and the gas turbines sold competitively with other prime movers. It is his opinion that the sale and use of the gas turbine will depend more upon the way it does a job in a specific application than on its cost as compared to other forms of heat engines.

Tin-Plating Process

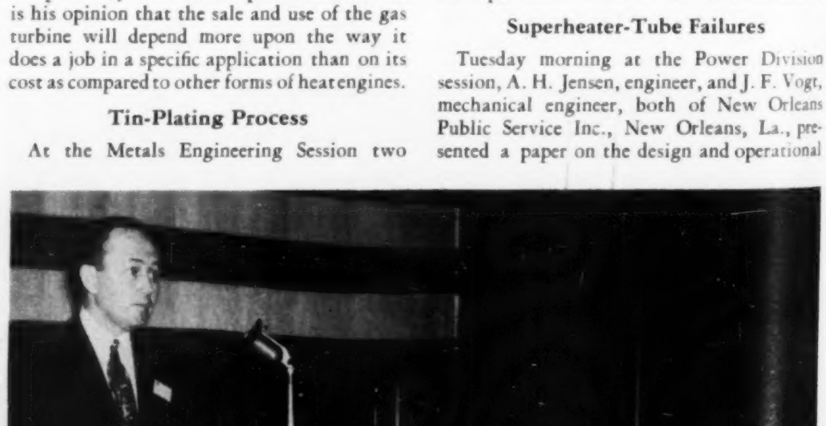
At the Metals Engineering Session two papers were presented. The first paper concerned itself with "Engineering the Tin-Plating Process" by Elmer T. Harris, Tennessee Coal, Iron, and Railroad Company, Birmingham, Ala. Mr. Harris stated that tin plate was truly a mass-produced tailor-made product. He described new developments which have eliminated much manual labor and have resulted in a better tin plate. He pointed out that although the term "tin can" means to most of us something to empty, discard, and forget, few realize the many processes that are necessary to produce tin plate for tin cans. He described new developments in tin plating that have resulted in elimination of heavy manual-labor jobs and have improved the quality of the product through minimizing kinks and damaged edges, bent corners and broken sheets, and the ability to produce larger-size plates. Mr. Harris pointed out that further investigation and development of tin-plate processes are under way at all times.

The other paper, "Engineering the Tin Can," was prepared by H. S. Van Vleet, chief, container research, research division, American Can Company, Maywood, Ill.

Dr. Van Vleet pointed out that the first tin can was patented by an English inventor in 1910 and that an expert employee could produce five or six cans per hour. Since that time, continued improvements in can-making have advanced the number to 20,000 per hr. Dr. Van Vleet described the years of research that gave the industry the necessary "know-how" to effect tin savings during the war years and how the technical committee of the Can Manufacturers Institute in December, 1941, formulated a tin-conservation program involving the use of electrolytic plate and bonderized black plate. Research on solders was also discussed. Dr. Van Vleet's paper was published in full on pages 315–320 of the April issue of MECHANICAL ENGINEERING.

Superheater-Tube Failures

Tuesday morning at the Power Division session, A. H. Jensen, engineer, and J. F. Vogt, mechanical engineer, both of New Orleans Public Service Inc., New Orleans, La., presented a paper on the design and operational



H. S. VAN VLEET SPEAKING AT THE METALS ENGINEERING SESSION
(*Left to right:* Dr. Van Vleet, E. T. Harris, S. D. Boxley, and J. P. Mercier.)

AT THE MANAGEMENT SESSION

(*Left to right:* E. G. Michaels, H. L. Armantrout, and L. W. Slathe.)

features of the Industrial Canal Steam Electric Station of New Orleans Public Service, Inc., which was visited later in the day.

H. B. Snider, general foreman, and F. H. Ward, chemical engineer, Humble Oil and Refining Company, Baytown, Texas, were authors of a paper which described the cause of superheater-tube failures in 275,000-lb per hr 650-psi boilers at Baytown Refinery. This paper also discussed the accuracy of steam-sampling devices.

Work Surveys Advocated

Also on Tuesday morning, papers were presented at the Management Session by E. G. Michaels, general manager, Southern Division, J. D. Woods and Gordon, Ltd., Greensboro, N. C., and R. W. Elsasser, management analyst, New Orleans, La.

Mr. Michaels described how methods not in accordance with traditional practices are generally viewed with misgiving. He advocated work surveys not only to determine that a manufacturing process is being performed with maximum efficiency, but also to pay particular attention to what the workers are thinking about their company and private industry in general. He advocated programs to keep workers informed of the actual facts of private industry so that their thinking would not be influenced by advocates of collectivism and other false ideologies.

Heat Transfer

On Wednesday morning at the Heat Transfer Session, an interesting paper was presented by C. F. Kayan, associate professor, Columbia University, New York, N. Y. The paper dealt with heat-transfer temperature patterns of a multicomponent structure by comparative methods. It also reported the comparative results of calculations for a thick two-dimensional corner composed of two different materials of unequal thickness, with fluid boundary conductance on each side. After pointing out the difficulties of calculation by orthodox procedures, he described methods used which included experimental "geometrical" and the network electrical analogies, as well as the solution of the equivalent electrical network by the process of arithmetic iteration.

Dielectric Heating Problems

Professor Kayan also read a paper prepared by M. P. Heisler, research assistant, department of mechanical engineering, Columbia University, New York, N. Y. Mr. Heisler's paper was "A Mathematical Analysis of a Number of Dielectric Heating Problems." This paper described the derivation of equations for use in engineering calculations of dielectric-heating problems. In developing these equations, a slab infinitely long and wide, but of finite thickness, made of a homogeneous material whose thermal properties do not change with temperature, was chosen for analysis. Charts were developed from the equations to facilitate use of the theoretical conclusions drawn.

Also on Wednesday morning, a paper was presented by Charles F. Kells, managing director, The Electric Industrial Truck Association, Long Island City, N. Y., entitled "Industrial Truck Methods of Materials Handling." The paper dealt with mobile tools and systems used for handling various types of materials including packaged materials and bulk materials. Slides were used to illustrate the types of equipment by which such materials could be most advantageously handled. General materials systems for various applications were also discussed.

Bagasse as Fuel

At the Thursday morning session, F. X. Gilg, application engineer, Babcock and Wilcox Company, New York, N. Y., presented a paper on "Utilizing Bagasse as Fuel." Mr. Gilg described the devices that have been developed for combustion of bagasse from the simple hand-fired Dutch-oven furnace up to present-day methods, where bagasse is continuously fed into the furnace, with its rate of combustion automatically controlled in accordance with steam requirements.

Following discussion of Mr. Gilg's paper, R. K. Allen, staff engineer, Babcock and Wilcox Company, New York, N. Y., outlined the "Developments in Kraft-Process Recovery Unit Design and Performance." His paper discussed the application of steam-generating equipment in pulp mills, using the B&W-Tomlinson method for combustion of black liquor from the Kraft pulping process, and the changes that have been made in this process since its initial development.

Pipe-Line Conversion

At the afternoon session, B. D. Goodrich, chief engineer, Texas Eastern Transmission Corporation, Shreveport, La., described the "Conversion of the 'Big Inch' and 'Little Big Inch' Pipe Lines from Oil Service to Gas

B. D. GOODRICH SPEAKING AT THE PROCESS INDUSTRIES SESSION

(*Left to right:* A. Durning, C. L. Nairne, and Mr. Goodrich.)

Transmission." One of the features of this conversion was the utilization wherever possible of existing equipment of gas-transmission purposes, and the development of a new type of gas centrifugal compressor. Interchangeability from oil transmission to gas transmission was thus simplified and a return to oil transmission, if ever necessary, would be much more difficult had not the methods described by Mr. Goodrich been utilized.

L. K. Spink, engineer, in charge of flow measurement, at the The Foxboro Company, Foxboro, Mass., read a paper on "Accurate Wide-Range Metering of Natural Gas With the Differential-Type Meter." Mr. Spink described the various methods used for measuring rapidly fluctuating flows as well as flows whose wide variation make readability under low-flow conditions difficult, when metered by orthodox methods.

Social Program a Success

In addition to the inspection trips, there was a luncheon held at the Patio Royal in the French Quarter for the visiting women, followed by a walking tour of the Quarter accompanied by professional guides. The women also enjoyed a boat ride on the Mississippi River where they were able to view the shipping activities in the busy New Orleans harbor.

Contributing greatly to the enjoyment of the meeting was a reception Monday night at International House which has received so much acclaim as an important factor in America's "good neighbor" policy. This was followed by a Barn Dance Tuesday night which was a major contribution to the conviviality of the entire meeting.

Grateful acknowledgment is made of the many committees whose contributions of time and effort made possible the success of the 1948 Spring Meeting.

Reported by C. L. NAIRNE.[1]

ASME Calendar

of Coming Events

May 20–22, 1948
ASME Oil and Gas Power Division Meeting
St. Louis, Mo.

May 31–June 5, 1948
ASME Semi-Annual Meeting
Milwaukee, Wis.

June 17–19, 1948
ASME Applied Mechanics Division Meeting
Chicago, Ill.

Sept. 7–9, 1948
ASME Fall Meeting
Portland, Ore.

Sept. 13–17, 1948
ASME Instruments and Regulators Division Meeting
Philadelphia, Pa.

Sept. 20–21, 1948
ASME Aviation Division Meeting
Dayton, Ohio.

Oct. 3–6, 1948
Petroleum Committee of the ASME Process Industries Division Meeting
Amarillo, Texas.

Nov. 3–4, 1948
ASME Fuels Division Meeting
White Sulphur Springs, W. Va.

Nov. 28–Dec. 3, 1948
ASME Annual Meeting
New York, N. Y.

Jan. 10–14, 1949
Materials Handling Division and Management Division Meeting
Philadelphia, Pa.

Institute on Heat Transfer and Fluid Mechanics Planned

THE ASME Sections of California are co-operating with other California sections of national engineering societies in sponsoring an Institute on Heat Transfer and Fluid Mechanics to be held June 21–23, 1948, on the campuses of the University of California, Los Angeles, University of Southern California, and the California Institute of Technology. The first day sessions will be held at the University of California, Los Angeles. On the second and third days the Institute will meet on the campuses of the University of Southern California and the California Institute of Technology, respectively.

The program, planned on a high scientific level, will present papers on the basic nature of heat transmission and fluid flow which are representative of the present state of engineering science.

Heat transfer at subsonic and supersonic speeds, boiling of liquids, heat transfer in porous metals, dynamics of cavitation, fluid flow at low pressures, and stability of the boundary layer with and without gas injection are among the subjects to be considered.

Other sponsors of the Institute are California sections of the American Institute of Chemical Engineers; American Society of Civil Engineers; American Society of Heating and Ventilating Engineers; Institute of the Aeronautical Sciences; the Fluid Mechanics Division of the American Physical Society; Jet Propulsion Laboratory of the California Institute of Technology; and Project SQUID, a co-operative research project of five eastern and five western universities.

Accommodations are being arranged for one hundred persons in the student houses of the California Institute of Technology for those who plan to attend the Institute. For reservations write to Dr. V. A. Vanoni, Hydrodynamics Laboratory, California Institute of Technology, Pasadena 4, Calif.

[1] Assistant to Executive Vice-President New Orleans Public Service, Inc., New Orleans, La. Mem. ASME.

Headquarters News Notes

PLANS are being made for publication this fall of the 1948 Membership List. Distribution will be limited to those members who request copies. If you want a copy, write at once to the Secretary. Early requests will assure sufficient copies for all who want them.

A special committee on clad vessels of the ASME Boiler Code held a public hearing in New York on April 5, 1948, to consider the proposed rules of construction for unfired pressure vessels that are provided with linings applied either in the ship or field.

Savannah Section is setting a tough pace in the drive for membership. Its Membership Development Committee exceeded its quota by more than 200 per cent.

President Appoints ASME Members to Advisory Committee

TWO ASME members, Hugh L. Dryden and Maj. Gen. Henry S. Aurand, were appointed recently by President Harry S. Truman to the Interdepartmental Committee on Research and Development established by executive order Dec. 24, 1947. The purpose of the new committee is to advise on the relationships among the numerous and complex Federal scientific activities or to take the leadership in the solution of administrative problems common to different Federal agencies.

Dr. Dryden, who is chairman of the ASME Publications Committee, is director of the Aeronautical Research of the National Advisory Committee for Aeronautics. General Aurand, who is currently serving on the ASME Nuclear Energy Application Committee, is chief, Logistics Division, General Staff, Department of the Army.

The new committee has been asked to obtain the advice of persons outside the Federal Government and to propose means by which information relating to the status and results of scientific research undertaken by the Federal agencies can be most effectively disseminated.

In announcing the comittee, the President said that the need for it was emphasized in the recent reports made to him by the Chairman of the Scientific Research Board. These reports clearly indicated that there was no central group equipped to advise on the relationships among the numerous and complex Federal scientific activities or to take leadership in the solution of administrative problems common to different agencies. The Federal research program with its large expenditures makes this committee a matter of national importance, he said.

History of the Diesel Engine in America to Be Featured at ASME 20th National Oil and Gas Power Conference, May 20–22

Headquarters: New Jefferson Hotel, St. Louis, Mo.

THE 20th National Conference of the Oil and Gas Division of The American Society of Mechanical Engineers will be held at the New Jefferson Hotel, St. Louis, Mo., May 20–22, 1948. The conference will commemorate the fiftieth anniversary of the introduction of the Diesel engine in the United States.

In addition to a program of five technical sessions, a luncheon, and a banquet, the conference will feature an exhibit of Diesel equipment and a preconference lecture course on lubrication.

A comprehensive survey of the history of the Diesel engine will be presented during the afternoon and evening sessions on Thursday, May 20. C. E. Beck, Mem. ASME, of the Nordberg Manufacturing Company, will begin the survey by covering the early developments of the Diesel engine. Ralph L. Boyer, Mem. ASME, will discuss application of large Diesel engines in the power industry. M. R. Bennett of the International Harvester Company will tell how the small Diesel engines are meeting the needs of industry. During the evening session, C. G. A. Rosen, Mem. ASME, of the Caterpillar Tractor Company, will review the Diesel-engineering developments made during the last half century.

Exhibit of Diesel Equipment

This year, as in the past, the Oil and Gas Power Division is sponsoring an exhibit of the latest developments in the Diesel industry as a feature of the Conference. The exhibit will contain engines, filters, governors, clutches, engine parts, and auxiliaries. More than 30 manufacturers are participating.

Preconference Lectures

Continuing an engineering service feature first instituted at the 19th Conference, where the subject of "Diesel Fuel Oils" was presented, the Oil and Gas Power Division is arranging a special series of lectures dealing with the ever-important subject, "Lubrication." This series, to be held at New Jefferson Hotel on May 19, will be presented at three 2-hour lectures by two recognized experts of national reputation. Mayo D. Hersey, research associate, Massachusetts Institute of Technology, will discuss "Basic Principles of Lubrication" and "Engineering Applications of Lubrication;" and Dr. James B. Rather, Jr., technical service department, Socony-Vacuum Laboratories, "Manufacture, Classification, and Test Significance of Lubricating Oils."

Registration, which will be restricted to approximately 100 engineers, should be made by mail to the Special Lectures Chairman, John C. Gibb, Room 1348, 26 Broadway, New York 4, N. Y. Fee for the complete series, payable in advance on application, is $12 to ASME members and $15 to nonmembers (checks should be payable to The American Society of Mechanical Engineers, Oil and Gas Power Division, Custodian Fund). Those interested are advised to make application without delay.

As a convenience to those attending the lectures, a special luncheon is planned for 12:15 p.m., between the morning and afternoon lectures.

The Tentative Program

THURSDAY, MAY 20

9:30 a.m.

Improved Techniques in Firing-Order Studies With the Vectorscope, by George Dashefsky, U. S. Navy Yard, Brooklyn, N. Y.

An Improved Method for Computing Torsional Vibration Systems, by A. W. Hussman (by title), University of Raleigh, Raleigh, N. C.

12:00 noon

Welcome Luncheon

Speaker: Honorable A. P. Kaufmann, Mayor of St. Louis.

2:00 p.m.

History (I) Session

Early Developments of the Diesel Engine, by C. E. Beck, Nordberg Manufacturing Company, Milwaukee, Wis.

Present-Day Diesel Engine, by Ralph L. Boyer, vice-president, Cooper-Bessemer Corporation, Vernon, Ohio, and M. R. Bennett, International Harvester Company, Chicago, Ill. Mr. Boyer will discuss large Diesel engines and Mr. Bennett will cover the small-engine field.

8:00 p.m.

History (II) Session

Diesel-Engineering Developments During the Last Half Century, by C. G. A. Rosen, director of research, Caterpillar Tractor Company, Peoria, Ill.

FRIDAY, MAY 21

9:00 a.m.

Application Session

Diesel in Industry, by W. T. Watt, vice-president, Maujer Publishing Company, St. Joseph, Mich.

Diesel in Inland-Waterways Operations, by A. R. Parsons, chief engineer, St. Louis Shipbuilding and Steel Company, and Donald T. Wright, editor, *Waterways Journal.*

Diesels on Salt Water, by Walter L. Green, vice-president, American Bureau of Shipping, New York, N. Y.

1:30 p.m.

Inspection Trips

Shops of the Busch-Sulzer Diesel Engine Company.

Inspection of a Nordberg Radial Diesel Engine at the Aluminum Ore Plant, St. Louis, Mo.

Inspection of a Diesel Towboat at the St. Louis Shipbuilding and Steel Company.

Visit to the Shell Lubrication Laboratory, Woodriver, Ill.

Visit to the Carburetor Company, St. Louis, Mo.

5:30 p.m.

Exhibitors' Social Hour

6:30

Banquet

Presiding: G. C. Boyer, chairman, ASME Oil and Gas Power Division.

Toastmaster: Gordon LeFeber, president, Diesel Engine Manufacturers Association.

Speaker: Joseph Holland, vice-president, Manufacturers Trust Company, St. Louis, Mo.

SATURDAY, MAY 22

9:30 a.m.

Application (II) Session

Centrifugal Blowers for Diesel Engines, by Robert Cramer, Jr., assistant chief engineer, Nordberg Manufacturing Company, Milwaukee, Wis.

Diesels on the Rails, by John Morris, general mechanical assistant, Atchison, Topeka, and Sante Fe Railway Company.

Wear Conferences Planned at MIT June 14–16

A SERIES of conferences on mechanical wear sponsored by the Massachusetts Institute of Technology in co-operation with the ASME and other engineering bodies, will be held on the campus of the Institute, Cambridge, Mass., June 14–18, 1948. The conferences will consist of all-day meetings devoted to discussions of the symptoms, causes, and fundamental mechanisms of wear between solid surfaces. The program will also include formal technical papers.

The purpose of the conferences is to present engineers and research workers with a summary of present knowledge regarding mechanical wear in the hope of bringing out by discussion an appreciation of what new information is needed and an indication of the most promising directions for future research on the factors of metallurgy, surface finish, atmosphere, lubricant, and wear testing. The following technical papers are to be presented:

Monday, June 14

Survey of Mechanical Wear, by R. W. Dayton, Mem. ASME, Battelle Memorial Institute.

Fuel and Lubrication Factors in Piston-Ring and Cylinder Wear, by A. G. Cattaneo, Mem. ASME, Shell Development Company.

Wear of Piston Rings, by Paul S. Lane, Muskegon Piston Ring Company.

Wear in Diesel Engines, by C. G. A. Rosen, Mem. ASME, Caterpillar Tractor Company.

Friction Wear of Certain Brake Materials, by J. H. Dedrick, University of Cincinnati, and John Wulff, Massachusetts Institute of Technology.

Tuesday, June 15

Wear in Steam Turbines, by N. L. Mochel, Westinghouse Electric Corporation.

Gear Lubrication and Wear, by J. O. Almen, General Motors Corporation.

Report of Recent Roll Tests on Endurance Limits of Certain Materials, by E. Buckingham, Mem. ASME, Massachusetts Institute of Technology, and G. J. Talbourdet, Mem ASME, United Shoe Machinery Corporation.

Hardness and Its Influence on Wear, by R. Holm, Stackpole Carbon Company.

Wednesday, June 16

Measurement of Minimum Oil-Film Thickness in Sleeve Bearings, by C. M. Allen, Jun. ASME, Battelle Memorial Institute.

Viscosity as a Factor in Wear, by H. Blok, Royal Dutch Shell Company, Delft, Holland.

Chemical Aspects of Lubrication and Wear, by R. G. Larsen, Shell Development Company.

Graphite Lubrication in Relation to Carbon Brush Wear, by R. H. Savage, General Electric Company.

Friction, Lubrication, and the Wear of Metals, by F. P. Bowden, Cambridge University, England.

For additional information write to Prof. J. T. Burwell, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.

Industrial Engineers Set Up New Society

A NEW professional engineering society, The American Institute of Industrial Engineers (AIIE) was organized recently with headquarters at Ohio State University, Columbus, Ohio. Among the objectives of the new body are the protection of society and industry through the identification of qualified industrial engineers, the promotion of the aims of the National Society of Professional Engineers, and advancement of industrial-engineering education in the universities.

Membership requirements are graduation from an accredited curriculum in industrial engineering, license as professional engineer, or recognized professional accomplishments in the field. Present membership is 40.

Note to ASME Members

COPIES of the new issue of the ASME Constitution and By-Laws, revised to Dec. 1, 1947, are now available and may be obtained by writing to the Secretary.

Conference on Industrial Physiology and Human Engineering Seeks to Promote Interprofessional Co-Operation

HOW to fit the machine to the man who must operate it so that production operations can be safe and reasonably comfortable, and how to create an industrial atmosphere in which men can work without emotional disturbance were two of the problems discussed at a one-day conference on industrial physiology and human engineering held at the Mellon Institute, Pittsburgh, Pa., March 23, 1948. The conference, sponsored jointly by the Mellon Institute and the University of Pittsburgh, was attended by more than 50 physiologists, physicians, psychologists, and industrial engineers and specialists.

The conference sought to define principles of design in respect to the human factor comparable to those which guide the engineer in functional design. Because the problem was one beyond the scope of any one profession, the conference arranged by Theodore F. Hatch, Mem. ASME, research director of the Industrial Hygiene Foundation of the Institute, was in some respects a test of the conference approach to the stimulation of interprofessional co-operation.

Aid of Medical Men Asked

Early in the discussions Lillian M. Gilbreth, Fellow ASME, called attention to the efforts of engineers and particularly the ASME in the field of biomechanics. Dr. Gilbreth called on medical doctors working in the industrial plants to convince managements to free some of their engineers to work co-operatively with plant physicians to promote safety and comfort of workers. Although engineers have much to contribute in this field, there have been unfortunate instances in the past where medical men, because of the lack of a common vocabulary, tended to undervalue the engineering contribution. It is in the schools, she said, where engineers and medical men must begin to learn to understand a common language.

As an example of the cost in time and money that has been paid for lack of co-operation between the physiologist and the engineer, J. F. McMahon, managing director of the Industrial Hygiene Institute, told of what happened to an early design of a tank in the last war.

The gun cavity, he said, was originally designed to fit the gun mount rather than the man who was to operate the gun. After the weapon was in the field, it was learned that the tank was often useless because the man with the required physical proportions to fit the cavity was not always on the scene. The tank was redesigned to add two inches to the height of the cavity, but the weight of the armour required to extend the protection overloaded the carriage and a complete redesign of the weapon was necessary.

Human Engineering Defined

Human engineering was a term which logically belongs to the field of biomechanics and should not be used carelessly to mean the subject matter of the social sciences, according to L. C. Mead, head of the Human Engineering Section, Special Devices Center, Sands Point, Port Washington, N. Y. Dr. Mead reported that his office was currently engaged in the preparation of a handbook on human-engineering data. The book would contain measurements of the human body and would indicate the distribution of the measurements among the population. Strength of muscles and other anthropometric data would be included, he said, to make the book of value to the engineering designer.

Others who attended the conference were Colin Carmichael, Mem. ASME, who represented the ASME Machine Design Division, S. C. Massari, Mem. ASME, technical director of the American Foundrymen's Association, and A. F. Bochenek, Mem. ASME, of the ASME Staff.

A. M. MacCutcheon to Receive 1947 Lamme Medal

THE 1947 Lamme Medal of the American Institute of Electrical Engineers has been awarded to A. M. MacCutcheon, who retired in 1946 from the position of vice-president in charge of engineering, Reliance Electric and Engineering Company, Cleveland, Ohio.

The award was made "for his distinguished accomplishments in the development of motors for industrial needs, notably in the steel industry." The medal will be presented to Mr. MacCutcheon at the summer general meeting of the Institute to be held in Mexico City, June 21–25, 1948.

The Lamme Medal was established through a bequest of Benjamin Garver Lamme, who was chief engineer of the Westinghouse Electric and Manufacturing Company from 1903 to his death in 1924. Beginning in 1928, the medal has been awarded annually for high achievements in the development of electric apparatus or machinery.

Material Specifications Addenda to ASME Boiler Code Available

A 120-page paper-bound booklet containing the 1947 addenda to the Material Specifications Section of the ASME Boiler Construction Code is now available for distribution. The addenda represents amendments to the Code made during 1947 to make the specifications in the ASME Code identical to the latest specifications of the American Society for Testing Materials. Copies may be obtained from ASME Publication-Sales Department, 29 West 39th Street, New York 18, N. Y. Price is $1.

ASME 14th Annual Conference on Applied Mechanics to Feature Symposium on Flow and Fracture of Metals

THE 14th Annual Conference on Applied Mechanics sponsored by the Applied Mechanics Division of The American Society of Mechanical Engineers in co-operation with the ASME Chicago Section, Armour Research Foundation, and Illinois Institute of Technology, will be held in the auditorium of the Chemical Engineering and Metallurgy Building of the Illinois Institute of Technology, June 17-19, 1948.

Four of the six technical sessions of the Conference will consist of a symposium on flow and fracture of metals, sponsored by the ASME Special Research Committee on Plastic Flow of Metals. A feature of the Conference will be the Applied Mechanics Dinner on Friday, June 18, at which W. M. Murray, chairman of the Applied Mechanics Division, will preside. Of special interest will be a visit to the editorial offices of the ASME publication, *Applied Mechanics Reviews*, which are located at the Technology Center of the Institute. Tours also have been arranged through the laboratories of the Armour Research Foundation and the Institute.

Rooming quarters for 60 persons will be made available in the Graduate House of the Institute. These will be of the dormitory-barracks type. Those who stay at the Graduate House will be able to use the North Student Union cafeteria for meals which are not scheduled as part of the regular program. For those who prefer hotel accommodations, arrangements are being made with downtown Chicago hotels.

The Tentative Program

THURSDAY, JUNE 17

Morning

Session (I)

Flow of a Compressible Fluid Through a Series of Identical Orifices, by C. S. L. Robinson, shipbuilding division, Bethlehem Steel Company, Quincy, Mass. (48—APM-4).[1]

The Decay of Isotropic Turbulence, by F. N. Frenkiel, graduate school of aeronautical engineering, Cornell University, Ithaca, N. Y. (48—APM-5).

Vibration of a Cantilever Beam With Prescribed End Motion, by G. A. Nothmann, college of engineering, Cornell University, Ithaca, N. Y. (48—APM-3).

Partitioning of Matrices in Structural Analysis, by S. U. Benscoter, structural engineer, National Advisory Committee for Aeronautics, Langley Field, Va. To be presented by title only. (48—APM-7).

Afternoon

Session (II)

Large Deformations of an Elastic Solid, by E. G. Chilton, Shell Development Company, Berkeley, Calif. (48—APM-8).

Contact of Elastic Spheres, by R. D. Mindlin, professor, civil engineering, Columbia University, New York, N. Y.

Three-Dimensional Solution for the Stress Concentration Around a Circular Hole in a Plate of Arbitrary Thickness, by E. Sternberg, fundamental mechanics research department, and M. A. Sadowsky, associate professor of mathematics, Illinois Institute of Technology, Chicago, Ill. (48—APM-21).

FRIDAY, JUNE 18

Morning

Session (III)—Symposium (I)

Flow and Fracture of Steel Under Combined Stress

Experimental Studies of Biaxially Stressed Mild Steel in the Plastic Range, by S. J. Fraenkel, research engineer, Armour Research Foundation, Chicago, Ill. (48—APM-1).

Behavior of Steel Under Biaxial Stress as Determined by Tests on Tubes, by H. E. Davis, associate professor of civil engineering, and E. R. Parker, associate professor of physical metallurgy, University of California, Berkeley, Calif. (48—APM-20).

The Effect of Size and Stored Energy on the Fracture of Tubular Specimens, by E. A. Davis, research engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa. (48—APM-12).

Afternoon

Session (IV)—Symposium (II)

Theory of Plasticity

Some Properties of a Mechanical Model of Plasticity, by P. Duwez, associate professor of mechanical engineering, and F. Bohnenblust, California Institute of Technology, Pasadena, Calif. (48—APM-10).

The Stress-Strain Laws of the Mathematical Theory of Plasticity—A Survey of Recent Progress, by W. Prager, professor applied mechanics, Brown University, Providence, R. I. (48—APM-14).

Stress-Strain Relations for Finite Elasto-Plastic Deformations, by J. E. Dorn, associate professor of physical metallurgy and A. J. Latter, formerly research engineer, University of California, Berkeley, Calif. (48—APM-15).

A Generalized Deformation Law, by E. A. Davis, research engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa. (48—APM-13).

The General Proof of the Principle of Maximum Plastic Resistance by A. Philippidis, Stanford University, Palo Alto, Calif. To be presented by title only. (48—APM-2).

SATURDAY, JUNE 19

Morning

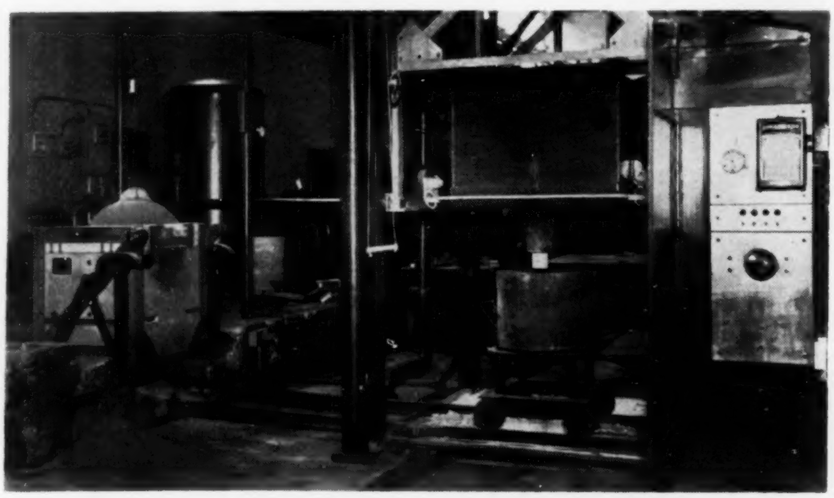
Session (V)-Symposium (III)

Impulsive Loading in the Plastic Range; Propagation of Discontinuities and Plastic Waves

Discussion of the Forces Acting in Tension Impact Tests of Materials, by D. S. Clark and P. Duwez, associate professors of mechanical engineering, California Institute of Technology, Pasadena, Calif. (48—APM-18).

A New Method of Making High-Speed Compression Tests on Small Copper Cylinders, by E. T. Habib, physicist, David Taylor Model Basin, Navy Department, Washington, D. C. (48—APM-9).

The Propagation of Plasticity in Uniaxial Compression, by L. Griffis, chairman, department of mechanics, Illinois Institute of Technology, Chicago, Ill., and M. P. White, professor of civil engineering, University



SOME OF THE RESEARCH FACILITIES OF THE ARMOUR RESEARCH FOUNDATION TO BE INSPECTED BY MEMBERS WHO ATTEND THE ASME 14TH ANNUAL CONFERENCE ON APPLIED MECHANICS, JUNE 17-19, 1948

[1] Preprint order number. Preprints will be on sale at the Conference. Copies may be ordered prior to the Conference from ASME Publication-Sales Department, 29 West 39th St., New York, N. Y.

of Massachusetts, Amherst, Mass. (48—APM-17).

The Interaction of Discontinuity Surfaces in Plastic Fields of Stress, by A. Winzer and G. F. Carrier, graduate division of applied mathematics, Brown University, Providence, R. I. (48—APM-16).

Afternoon

Session (VI)-Symposium (IV)

Plastic Flow and Fracture

A Law of Work Hardening, by A. M. Freudenthal and M. Reiner, department of theoretical and applied mechanics, University of Illinois, Urbana, Ill. (48—APM-6).

The Influence of the Dimensional Factors on the Mode of Yielding and Fracture in Medium-Carbon Steel, Part I, The Geometry and Size of the Flat Tensile Bar, by J. Miklowitz, University of Michigan, Ann Arbor, Mich. (48—APM-19).

Plastic Deformation of Circular Steel Diaphragms, by A. Gleyzal, David Taylor Model Basin, Navy Department, Washington, D. C. (48—APM-11).

Contact Stresses in the Rolling of Metals, by C. W. MacGregor, professor of applied mechanics, and R. B. Palme, staff member, division of industrial co-operation, Massachusetts Institute of Technology, Cambridge, Mass.

Research Program Planned by Army for Reserve Officers

A COMMITTEE of scientists and engineers who hold commissions in the Organized Reserve Corps, met in the Pentagon on March 26–27, 1948, to consider the details of the Army's newly proposed research and development program for reserve officers. Meeting under the sponsorship of the Research and Development Group, Logistics Division, General Staff, which sponsors Army Research and Development, the Committee unanimously approved the contemplated program and submitted a report strongly recommending its immediate establishment. It further recommended formation of procedures for optimum utilization of the technological skills of all reserve officers professionally engaged in the medical, biological, physical, and engineering sciences.

Under the program as proposed by the Scientific Manpower Section of the Research and Development Group, reserve officers who are professional scientists would be enabled to pool their technological competence for concentrated attack on Army research and development problems as well as to keep abreast of the Army's technological progress. It is also contemplated that the program will result in effective mobilization assignments for key scientists to insure rapid and proper mobilization in event of an emergency.

ASME Membership List Planned for Fall

PRODUCTION schedules are now being arranged looking toward the publication in the late fall of a new ASME Membership List. It will contain both alphabetical and geographical listings. Members will not receive cards requesting information for the new list, but are urged to keep their records up to date by means of the form published monthly in MECHANICAL ENGINEERING (see next page).

Members who desire copies of the new list should write the Secretary promptly so that a sufficient number of copies will be printed. The Membership List is not available to nonmembers of the ASME; nor is its use permitted for commercial, promotional, or other circularization purposes.

Navy Seeks Qualified Men for Expanded Research Program

THE Navy Department is currently expanding three comparatively new, permanent laboratories in California, and implementing its scientific research and development program both geographically and in new fields of endeavor. Heretofore, the Navy Department's scientific centers have been concentrated in the eastern and western seaboard areas.

Two of the laboratories have been established as the logical outgrowth of programs carried on by universities during the war. The Naval Ordnance Test Station, China Lake (formerly Inyokern), Calif., 160 miles from Los Angeles, was originally an activity of the California Institute of Technology. Its present program involves research, development, and test work with ordnance equipment and explosives. The Navy Electronics Laboratory at San Diego, Calif., is the outgrowth of work done by the University of California. It is concerned with research, testing, and development of electronic control devices, detection equipment, instrumentation equipment, and training aids. The Naval Air Missile Test Center at Point Mugu on the coast of California, 60 miles north of Los Angeles, was established when the need for an installation became apparent as the result of the Navy Department's activities on guided missiles. The Test Center's activities are concerned with flight and laboratory testing and evaluation of guided missiles and their components.

Each of the establishments has current need for qualified personnel in a variety of

ARMY RESERVE CORPS COMMITTEE OF SCIENTISTS AND ENGINEERS WHICH MET RECENTLY TO CONSIDER A RESEARCH AND DEVELOPMENT PROGRAM FOR RESERVE OFFICERS

(*Seated, left to right:* Col. C. E. Davies, secretary ASME, Col. W. N. Carey, secretary ASCE, Col. E. A. Routheau, Brig. Gen. Norman Lack, Maj. Gen. A. C. McAuliffe, Maj. Gen. J. C. Danfquist, Gen. B. F. Caffey, Col. J. H. Ferrick; and Lieut. Col. A. S. Behrman. *Standing, left to right:* Col. John N. Andrews, Lieut. Col. V. M. Elmore, Maj. S. C. Rothmann, Maj. Ruell A. Sloan, Maj. R. B. Finch, and Dr. David M. Delo.)

scientific fields to staff its laboratories. Recently completed at the Naval Ordnance Test Station at a cost of $6,000,000 is Michelson Laboratory. Many more millions of dollars have been spent in equipment and facilities. Additional construction and facilities are planned for both the Air Missile Test Center and the Electronics Laboratory.

The work programs of the laboratories are planned, directed, and accomplished under the direction of a staff of civilian scientists. Extensive use is made of the council method of operation. Constant liaison is maintained with other research organizations, universities, scientific associations, and outstanding authorities throughout the nation.

Professional positions are available in the career service of the Federal government under Civil Service laws. Examinations are now open in the three scientific establishments in the following professional fields: chemist; mathematician; metallurgist; meteorologist; physicist; statistician; scientific research administrator; and scientific staff assistant.

Salaries for most of the positions range from $3397 to $9975 per year. Salaries are predicated on the level, knowledge, and experience required to discharge effectively the duties of a specific position.

Further information may be obtained from the Navy Department Joint Board of U. S. Civil Service Examiners, 1030 East Green Street, Pasadena 1, Calif.

Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

The mailing form on this page is published for your convenience. You are urged to use it in reporting recent changes.

Your mailing address is important to Headquarters. Please check whether you want your mail sent to home or office address.

New Quarterly Published by New York University

THE Institute of Mathematics and Mechanics of New York University, New York, N. Y., has recently announced publication of a new quarterly journal, *Communications on Applied Mathematics*. The journal will be devoted to contributions in the fields of applied mathematics, mathematical physics, and mathematical analysis. While the first two issues are concerned with water waves, subsequent issues will deal with linear and nonlinear problems in elasticity, including nonlinear vibrations; fluid dynamics, gas dynamics, and applications to aerodynamics; problems of combustion; turbulence; and many others. Single copies sell for $2.50. Annual subscription is $8.

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Notify Headquarters Promptly of Changes

Boiler Code Committee to Hold May Meeting in Boston, Mass.

FOR the first time since its organization in 1911, the ASME Boiler Code Committee will hold one of its regular monthly meetings in Boston, Mass., on May 24, 1948, at the Parker House Hotel. The meeting is significant because it was a boiler catastrophy in the neighborhood of Boston and the pioneer work of Massachusetts engineers in the field of boiler safety which lay the groundwork for the ASME Boiler Code.

The historical association of the Massachusetts Board of Boiler Rules and the ASME Boiler Code Committee will be commemorated by a special meeting on May 25, sponsored by the ASME Boston Section and the National Board of Boiler and Pressure Vessel Inspectors.

It was following a serious boiler explosion in Lynn, Mass., in which 300 persons lost their lives, that the Massachusetts legislature, aided by local engineers, transformed a loose set of boiler-inspection rules into an effective safety document which specified a rigid inspection routine and laid down specific rules for boiler construction. While the rules were effective in reducing boiler explosions in the state, catastrophies continued to occur in other states. Recognizing the excellence of the Massachusetts rules, the AS ME in 1911 sponsored its own safety code copied closely after the work of the Boston engineers. The new code made available a document of national significance backed up by the prestige of the Society, which other state legislators could adopt or modify as a basis for their own boiler-safety rules. While some manufacturers were reluctant to support the new Code because it was alleged that the Code would result in prohibitive construction costs, experience since has shown that these costs were only increased to a slight extent. In the past 31 years the ASME Boiler Construction Code has been made the basis of pressure-vessel laws in 29 states and 13 cities of the Union, and six provinces of Canada.

Following the special meeting, some of the members of the ASME Boiler Code Committee will participate in the annual meeting of the National Board of Boiler and Pressure Vessel Inspectors to be held at the Parker House, Boston, Mass., May 26 and 27, 1948.

Public Hearing Considers Proposed Rules for Lined Vessels

AS a result of a two-day public hearing of the Special Committee on Clad Vessels of the ASME Boiler Code Committee held in New York, N. Y., April 5 and 6, 1948, the proposed rules covering construction of fusion-welded vessels lined with weldable types of corrosion-resistant materials were considerably simplified and revised. More than 30 representatives of pressure-vessel users, designers, and fabricators, about half of them from the petroleum industry, participated in the discussions.

The hearings were called because of the question whether, under the rules of Section VIII of the Code, it was permissible to construct fusion-welded pressure vessels that are lined with corrosion-resistant materials welded either to the plates before forming or to the shell, heads, or other parts after assembling the welding of the base-metal parts. Because the contemplated methods of attaching the lining materials will not produce composite materials meeting the continuous-bonding requirement for clad materials covered by the Committee's ruling on Case 986, additional rules had to be drafted to cover the special case of the lined vessel. These proposed rules were the subject of the hearings.

The informative suggestions brought out in the discussion by the representatives of all phases of the industry will now be considered by the Boiler Code Committee at its meetings in May and June.

Meetings of Other Societies

May 9–12
American Institute of Chemical Engineers, Cleveland meeting, Hollenden Hotel, Cleveland, Ohio.

May 13–14
American Management Association, production meeting, Palmer House, Chicago, Ill.

May 27–29
Society for Experimental Stress Analysis, annual meeting, Roosevelt Hotel, Pittsburgh, Pa.

May 30–June 2
The American Society of Refrigerating Engineers, spring meeting, Ocean House, Swampscott, Mass.

June 1–5
The Engineering Institute of Canada, annual general and professional meeting, Banff Springs Hotel, Banff, Alberta, Can.

June 6–11
Society of Automotive Engineers, Inc., semiannual meeting, French Lick Springs Hotel, French Lick, Ind.

June 14–18
American Society for Engineering Education, annual convention, Austin, Texas.

June 21–25
American Institute of Electrical Engineers, summer general meeting, Palace of Fine Arts, Mexico City, Mex.

June 21–27
American Society for Testing Materials, annual meeting, Detroit, Mich.

July 20–22
American Society of Civil Engineers, annual convention, Hotel Olympic, Seattle, Wash.

Translation of German Book Published by ASME

PUBLICATION by The American Society of Mechanical Engineers of a German monograph, "The Dynamics of Automatic Controls," by R. C. Oldenbourg and H. Sartorius has been announced.

The volume came to the attention of American engineers in 1945 when specialists in the field of industrial instrument controls visited Germany to study advances made during the war by German industry. The thoroughness, simplicity, and clarity of work so impressed members of the ASME Industrial Instruments and Regulators Division that it was decided to sponsor a translation of the book to make available to American engineers a good theoretical work in English on automatic controls.

Henry L. Mason, research professor of mechanical engineering, Iowa State College, Ames, Iowa, who translated the book, says in the preface to the ASME edition, "For clearer understanding by the American reader, needed explanatory phrases have been added in the body of the text. Teutonicisms have been omitted, technical and correlating footnotes have been provided, and both the bibliography and the subject index have been extended. ASME definitions of automatic-control terms have been generally used, ASA symbols have been introduced, and additional symbols have been changed to suit English mnemonics."

A review of the book by Professor Mason was published on pages 474–475 of the May, 1946, issue of MECHANICAL ENGINEERING.

Copies may be ordered from ASME Publication-Sales Department, 29 West 39th St., New York 18, N. Y. for $7.50 per copy.

British Engineers Sponsor International Conference of Engineering Bodies

THE Engineers Joint Council has been invited to participate in a conference of Western European and American professional engineering societies to be held in London Oct. 4–9, 1948, under the joint sponsorship of The Institution of Civil Engineers, The Institution of Mechanical Engineers, and The Institution of Electrical Engineers, the "big three" among British engineering bodies.

The purpose of the conference will be to improve international co-operation in the engineering profession. The principal engineering organization from each of the following countries has also been invited: Belgium, France, Norway, Switzerland, Denmark, Holland, and Sweden.

Tenth Management Course Offered by Iowa State University

THE Tenth Management Course of the State University of Iowa, Iowa City, Iowa, will be given June 7 to 19, 1948. The course is designed for engineers who want comprehensive training in production planning, job evaluation, motion and time study, wage incentives, plant layout, and related subjects.

NACE Elects New Officers

F. L. LAQUE, development and research division, The International Nickel Company, Inc., New York, N. Y., was elected president of the National Association of Corrosion Engineers at the annual meeting of the Association held at Hotel Jefferson, St. Louis, Mo., April 7, 1948.

Others elected were: H. H. Anderson, vice-president; O. C. Mudd, treasurer; L. J. Gorman, D. E. Stearns, and V. N. Jenkins, directors.

Professional Membership Grade Established by SPE

IN A move to maintain high standards of membership, the Society of Plastics Engineers has established a professional-grade membership predicated on 10 years of qualifying experience in the plastics industry.

An applicant having a doctor's degree in science or engineering will be allowed seven years' credit and will therefore need only three additional years of qualifying experience to be eligible for a professional-grade membership. Similarly, candidates with a master's or bachelor's degree will be credited with six and four years, respectively. A bachelor's degree from a nontechnical college will rate a two-year experience credit.

Three International Congresses to Be Held in Europe During Summer

INTERNATIONAL congresses in the fields of applied mechanics, soil mechanics and foundation engineering, and bridge and structural engineering will be held in western Europe this summer.

Applied Mechanics

Seventh International Congress of Applied Mechanics will be held at the Imperial College of Science and Technology, South Kensington, London, England, Sept. 5–11, 1948.

The technical sessions will be organized under the following sections: (1) Elasticity and plasticity; (2) aerodynamics, hydrodynamics, meteorology; (3) thermodynamics and heat transfer; (4) vibrations, lubrication, and experimental methods. In addition, as many as ten general lectures or surveys are contemplated on subjects likely to be of interest to members.

Arrangements have been made for visits to the National Physical Laboratory, the Royal Aircraft Establishment, the National Gas Turbine Establishment, and the General Electric Research Laboratories during the week following the Congress.

Forms of application for membership and other material concerning the International Congress of Applied Mechanics are now available and can be obtained from the Organizing Secretary, Seventh International Congress of Applied Mechanics, Imperial College of Science and Technology, London, S.W. 7.

Soil Mechanics

The Second International Conference on Soil

Mechanics and Foundation Engineering will be held in the Palace Theater, Zomerhofstraat, Rotterdam, Holland, June 22–26, 1948.

Meetings on earth constructions, earth pressure, ground water, and raft and pile foundations, will be held June 23; on laboratory and field investigations, June 24; on roads, runways, soil stabilization, and theoretical subjects, June 25. Visits to the Delft Laboratory have been arranged for June 22 and 23, and excursions from June 26 to 29. It is planned to publish six volumes of proceedings, involving some 500 papers and priced at approximately $30 per set.

Further information can be obtained by addressing the Conference in care of the Laboratory of Soil Mechanics, Oostplantsoen 25, Delft, Holland.

Bridge and Structural Engineering

The 1948 Congress of the International Association for Bridge and Structural Engineering will be held in Liege, Belgium, during the first half of September, 1948. Only members of the IABSE may take part. The meetings will be organized under the subjects: (1) Assembling devices and structural details in steel structures; (2) developments in building structures in concrete and masonry; (3) developments in long-span steel bridges, (4) slabs and various curved structures of reinforced concrete; (5) analysis of safety and effect of dynamic forces. The contributions will be published in English, French, or German, with summaries in the other two languages.

Further information may be obtained from Dr. F. Stussi, Swiss Federal Institute of Technology, Zurich, Switzerland.

Savannah Section Leads in Membership Drive

THE Membership Development Committee of the Savannah Section, under the chairmanship of Alex C. Ormond, is setting a fierce pace in the ASME membership-development drive. At the halfway mark of the year, the Savannah Section exceeded by more than 200 per cent its assigned quota. The Nebraska Section, which has met its quota, holds second place.

Mr. Ormond attributes the success of the Savannah Section to the enthusiasm with which the members talk about the ASME to prospective members and the effort they make "mixing-in" during Section meetings.

In his midyear report on membership-development affairs, A. C. Pasini, chairman of the national committee, points out that the most important step that a Section can take is to encourage closer liaison between the Section and the student branches within the Section. He suggests that "Section officers and the Membership Development Committee should encourage the honorary chairmen of student branches in every way possible." By furnishing data to student members and by providing speakers for student-branch meetings, the Section can create a loyalty to the ASME among students which may lead to transfer to the junior-member grade after graduation.

Actions of the ASME Executive Committee

At a Meeting Held at Headquarters, April 2, 1948

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, April 2, 1948. There were present: E. G. Bailey, chairman, F. S. Blackall, Jr., F. M. Gunby, J. N. Landis of the Executive Committee; E. J. Kates, and A. R. Mumford of the Council; K. W. Jappe, treasurer; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary.

Resolution of Thanks

A resolution was adopted, expressing thanks of the Society to all organizations and individuals who contributed to the success of the New Orleans Spring Meeting.

ASA By-Law Amendment

The Committee approved a recommendation of the Standardization Committee, concurred in by the Board on Codes and Standards, expressing the objections of the ASME to the proposed amendment to the By-Laws of the American Standards Association which would authorize the designation of ASA correlating committees as sponsors for standardization projects.

Uniform Grades of Membership

General approval was given to ASME participation in the project of the Engineers' Council for Professional Development concerned with standardization of grades of membership in the various engineering societies. It was urged that the Society work toward increasing the standards for admission to the profession.

Delegation of Authority

Following consideration of a statement of policy drafted by the Board of Membership in which the Board offered to relieve the Council of certain duties relating to review of actions of the Admissions Committee, the belief was expressed that the Council would be willing to delegate its responsibility for election and transfer of members in all grades except the Fellow grade. Certain changes in the By-Laws would be necessary and the Board was encouraged to proceed with initiating these changes.

Engineers Joint Council

Following a discussion of the Engineers Joint Council report of the Organization of the Engineering Profession, during which President Bailey reported a communication from the president of the American Institute of Electrical Engineers encouraging action on the organization of a single engineering society to represent all engineers, a statement of policy was adopted for discussion at the meeting of EJC on April 26.

EJC Constitution

Since no further changes had been recommended in the draft of the Constitution and By-Laws of the EJC, tentatively approved by the Committee at a previous meeting, the ASME representative to the EJC was authorized to report full approval by the Society.

Promotion of Understanding

To promote understanding between the presidents of the participating societies of the EJC, it was voted to distribute to these officers, monthly issues of MECHANICAL ENGINEERING and essential publications describing Society activities.

Deaths

The report of the deaths of James H. Herron, past-president ASME, on March 29, 1948, and George L. Knight on March 27, 1948, was noted with regret.

Appointments

Appointments on committees and joint activities recommended by the Organization Committee were approved. The following appointments were confirmed:

Frederick K. Teichman, International Air Transport Luncheon Committee, Society of Automotive Engineers.

P. G. Exline, American Petroleum Institute Lubricants Committee.

Philip T. Sprague, Iowa State College, 90th Anniversary Celebration.

Harry A. Hopf, visit to Europe, honorary vice-president.

William L. Batt, Morehead Patterson, Theo. von Kármán, Howard Coonley, H. B. Maynard, as honorary vice-presidents to the Centennial celebration of the Société des Ingenieurs Civils de France.

Atomic Energy Fellowships Offered

THE National Research Council is announcing a new program of fellowships supported by funds provided by the United States Atomic Energy Commission as a part of the Commission's responsibility for future atomic energy research.

Fellowships are available to young men and women who wish to continue in graduate training or research for the doctorate in an appropriate field of science. Others will provide training in biophysics applied to the control of radiation hazards. A number of fellowships will be assigned to those below the age of 35 who have already achieved the doctorate and who wish to secure advanced research training and experience in those aspects of the physical, biological, and medical sciences related to atomic energy.

Awards will be made for the academic year 1948–1949. The program is administered by the National Research Council. Further information can be secured by writing to the Fellowship Office, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

ASME Junior Forum

COMPILED AND EDITED BY A COMMITTEE OF JUNIOR MEMBERS, C. H. CARMAN, JR., CHAIRMAN

The Next Forum

BECAUSE of the normal lull in ASME Section activities during the summer months, the next issue of the Junior Forum will appear in October. In the meantime, the Junior Forum Editorial Committee will reorganize under a new chairman, new members will be recruited, and an effort will be made to set up an advisory editorial committee composed of junior members residing in the other seven Regions of the Society.

The uncertainty which plagued the Editorial Committee when the Forum was initiated in October, 1947, was dissolved by the support received at the meeting of junior members held during the 1947 Annual Meeting at Atlantic City, and more recently by the returns from the current readers survey of MECHANICAL ENGINEERING being made each month by the headquarters editorial staff.

One of the questions asked in the survey is "What reports and news stories on ASME affairs and related activities did you like?" In the February returns, 14 of the 49 cards named the Forum and some contained favorable comment. On the basis of this evidence and the many letters received from juniors, the Committee has confidence in the future of the Forum.

If the Forum is to reflect the place of the junior member in the Society, to record his thinking on professional matters and his part in Society affairs, some way must be found to make the Forum a national project of the ASME junior members. While the Editorial Committee has sought and has received the co-operation of juniors in other Sections, it has been aware that a committee, composed solely of members of the Metropolitan Section, no matter how competent, cannot do justice to the needs of juniors residing in Regions remote from the New York area.

Advisory editorial committees in each of the ASME Regions offer one of the solutions to this problem. For junior members who have had or who seek editorial experience, service on these committees offers opportunities for pleasant associations as well as an introduction to the publication activities of the Society. Since all significant Society activities are eventually recorded in ASME publications, the publications touch on every phase of the life of the Society.

If it is true that the best way to study the details of a machine is to attempt to draw it, then it is equally true that the best way to learn about the complex operations of a great engineering society is to write about them. In addition to the satisfaction that comes from service, the advisory editorial committees can offer the junior member practical knowledge of how things are done in the engineering profession, and probably of more value, why they are done in some particular way.

Getting Started

THE young graduate should not try to impress his fellow workers with the extent of his knowledge. The truth will leak out soon enough.[1]

Junior members who want to accept Regional responsibility for the Forum and want to know how they can serve their fellow juniors, are urged to write to C. H. Carman, Jr., Elliott Company, 225 Broadway, New York 7, N. Y.

An Opportunity for Juniors

ASME Junior Groups have been taking increasing interest in their local student-branch activities. The enthusiasm in organizational affairs of student branches is encouraging to those who have made an effort to promote undergraduate participation. The Junior Groups should be concerned with this program for therein lies the greatest source of new members for the Society.

In the past eight years the number of student members has doubled, and today 34.5 per cent of the total membership in ASME are students. These statistics explain the need for an intensive campaign to insure the continued interest of the student branches in the parent Society.

The situation is resolved into two questions: What do the student groups expect of ASME, and what can the juniors do to help the student members to derive maximum benefit from their affiliation with the Society?

In answer to the first question, it can be said that the average student wants to feel that he is an integral part of the organization and that this organization is interested in his activities, the problems of his branch and his engineering curriculum. Merely proclaiming interest is not enough. The Society must demonstrate its concern over the welfare of the younger members of its fold.

The initiative for action rests squarely with the Junior Group. Details of such a program are entirely dependent upon the ingenuity and ideas of the respective Section chairmen and committeemen. Of primary consideration is the geographic proximity of the student branches in certain sections of the country. Groups located in the Midwest cannot meet as often as those situated in the Metropolitan Section. The following suggestions, however, are generally applicable to the Junior Groups in all regions:

1 Invite the chairmen, and honorary chairmen, of the local student branches to Junior Executive Committee meetings. Introduce them to the Committee and, most important of all, to each other.

2 Upon request, offer assistance and advice to the branches in planning special meetings and conventions.

3 Encourage joint meetings of junior and student groups with talks, forums, and films. Functions such as these provide the junior members with the opportunity of welcoming the students into the affairs of the society.

4 A committee of junior members can be appointed to contact graduating seniors, either individually or as a group, to encourage them to transfer to the junior grade of membership.

JEROME H. MANDEL[2]

[2] Turner Construction Company, New York, N. Y. Jun. ASME.

Status of ASME Junior Activities

AS one of the projects of the ASME Junior Committee, Chairman Donald E. Jahncke has been corresponding with key members in the various Sections. A few of the 23 letters he has received follow. The letters are edited slightly.

Plainfield Section

Dear Mr. Jahncke:

The Plainfield Section has only about 270 members and there is no attempt to have junior activities. In my long association with this Section, I have never found any segregation of junior and member activities. As it so happens, I am a junior member and a few of the Executive Committee are also junior members. Most of the activities of this Section are carried on by men in their thirties and will probably remain so because the older active members feel that this is as it should be.

Perhaps it would be of interest to know how we obtained members of our Executive Committee. The members of the Executive Committee talk to the members during the refreshment period following the meeting. When the Committee have found that an individual attends regularly, we strike up a personal friendship with him. He is then invited to attend the "dutch treat" dinner and monthly Executive Committee meeting. If his interest is such that he avails himself of this opportunity throughout the year he may be elected to the Executive Committee

[1] New Proverbs for Young Engineers, by Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y. Mem. ASME.

for the following year and after some years of service on the Executive Committee, he may prove to be of officer material. In this way the junior is part of the Section through the wise and unselfish guidance of the older members.

With a small section like ours, it is possible to operate on this "society friendship" basis and I believe there is no need for special recognition of the junior member.

Gordon Hodge.[3]

Waterbury Section

Dear Mr. Jahncke:

Junior activity in the Waterbury Section has been encouraged to a large extent. As our Section is of moderate size, it is possible for the junior to serve on committees, hold office, and in general to obtain a hearing.

This would indicate to me that in our particular situation there is no difference in the local Section between grades.

I, myself, am a junior member.

Walter E. Allan.[4]

Rochester Section

Dear Mr. Jahncke:

The Rochester Section has long been aware of the problem of encouraging and promoting junior activities here locally. The majority of the new members joining the Society are juniors and about 50 per cent of our total memberships are juniors.

We make an effort to invite each of our new members to one or more of the Executive Committee meetings as well as to our general technical meetings with the Rochester Engineering Society. In this way an effort is made to know each new man coming into the Society. We also aim to have the junior members represented on the Executive Committee, and a certain number of juniors are also chosen as candidates for election to the Executive Committee. Some of our past chairmen have been junior members.

At the present time, we are attempting through co-operation with the Student Branch of the University of Rochester, to list all student members who have or are recently graduated. These men will be the potential nucleus of the new junior members of the Society, and we plan to contact each one in the area personally so as to make sure he is aware of his opportunity to convert his student membership to that of a junior.

Stanley C. Stacy.[5]

Pittsburgh Section

Dear Mr. Jahncke:

The Pittsburgh Section has recognized the need for increased activities in the field of the ASME junior and student members, and this year appointed a committee to concentrate on students and recent graduates affairs. The chairman of our Students and Recent Graduates Committee is A. J. Kerr, Rockwell Manufacturing Company, 400 N. Lexington Ave., Pittsburgh 8, Pa.

E. W. Jacobson.[6]

Virtue

To go places in an organization be known as the man who does what he said he would do and gets it done on time.[1]

North Texas Section

Dear Mr. Jahncke:

There have been no activities of the junior group apart from the member group in the North Texas Section. However, three juniors are serving on the Executive Committee of the North Texas Section: C. A. Besio as program chairman, A. R. Mozisek as membership chairman, and myself as secretary-treasurer. There have been as many juniors as members attending the meetings.

It appears that the juniors have a voice in local affairs and as a whole have been fairly active in this Section. Our problem, as I see it, is to stimulate the Section as a whole and at the same time have a program that will appeal to the younger crowd. In case the older fellows think the program leans a little too much toward things that appeal to the youngsters, perhaps they should make a move to separate the members from the juniors. I think the older fellows go for about the same kind of program that appeals to the juniors; hence a live-wire Junior Group, functioning as an integral part of the Section can put more pep into the organization as a whole and benefit both the juniors and the members.

Glyn Beesley.[7]

Oregon Section

Dear Mr. Jahncke:

The Oregon Section is a relatively small Section having approximately 65 persons in the Portland area with an additional 35 members scattered throughout the remainder of our district. The Section became very weak during the war years, but is at present strengthening its position and within a few years should be one of the strongest and most active sections of the Society.

It is my feeling that if the junior members were to operate independently, this Section would be seriously handicapped, since it seems necessary to rely upon many of the junior members in carrying out the expanded program that is being developed. It is possibly true that an independent junior organization would increase the number of new junior members to a certain extent and arouse the interest of some of those that are now stagnant, but we believe that in our case this can be accomplished better by our operating as a single unit rather than as a divided group.

A general outline of the activities of the Section that foster junior-member activity is listed below:

(1) An educational program, being developed, is aimed specifically toward assisting the young engineer in passing the registration exam of the Oregon State Board of Engineering Examiners. Classes are already under way and will be expanded at a later date.

(2) A publications committee is being selected to publish a Section roster as well as a regular Section news sheet. Junior members will probably be selected to provide the working force for this committee. In addition, we expect to select one of our junior members to contribute regularly to the Junior Forum.

One of the indications of the extent of activity of the junior members of this Section is shown by the number of offices held by members of this group. Junior members hold the following offices: Vice-chairman, secretary, treasurer, and membership chairman.

Much work remains to be done. The following problems are being considered and it is believed that the junior members will feel closer to the Society by taking an active part in their execution:

(1) More active participation in civic problems. This will require the convincing of the local employers that it is to their advantage to permit their engineers, as well as their sales personnel, to participate in programs wherein some of the meetings or a portion of the meetings occur during the normal working hours.

(2) A program that will permit the junior members to become acquainted with the older members of the local Section.

(3) A program that will permit the ASME members to become more familiar with the functions and operations of the Society and thereby feel closer to it.

I am sure that you are aware of the fact that the ASME 1948 Fall Meeting will be held in Portland. The Oregon Section is determined to make this meeting one of the best ever presented by any Section. The accomplishment of this end will require the efforts of all members and will result in the assignment of nearly all members to committees. It is the belief of the Executive Committee that this undertaking will arouse the interest of the junior members and permit them to feel that they are making some contribution to the Society.

Paul D. Christerson.[8]

Basic Talents

Learn young how to meet people, sell things, handle tools, do the everyday chores of business and industry.[1]

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[3] Development Engineer, Worthington Pump and Machinery Corporation, Harrison, N. J. Jun. ASME.

[4] Tool Engineer, Waterbury Brass Goods Division, American Brass Company, Waterbury, Conn. Jun. ASME.

[5] Mechanical Engineer, Board of Education, Rochester, N. Y. Mem. ASME.

[6] Chief Design Engineer, Gulf Research and Development Company, Pittsburgh, Pa. Mem. ASME.

[7] Turbine Field Engineer, General Electric Company, Dallas, Texas. Jun. ASME.

[8] Junior Engineer, Willamette Iron and Steel Corporation, Portland, Ore. Jun. ASME.

COMMITTEE OF PHILADELPHIA JUNIORS RESPONSIBLE FOR THE SECOND ENGINEERING PROGRESS SHOW

(*Seated, left to right:* Curt Yamas; Wayne Astley, Jun. ASME, Joseph E. Quinn, Jun. ASME, chairman; Warren van de Vort; Lewis Kenney, Mem. ASME, senior adviser; Robert L. Braun, Jun. ASME; H. Nelson Jacobs. *Standing, left to right:* Wilmot Fleming, Conrad Fowler, Victor G. Thomassen, senior adviser.)

Second Engineering Progress Show Tremendous Undertaking for Philadelphia Juniors

WHEN it comes to planning boldly and accepting responsibility unflinchingly, junior members of the ASME Philadelphia Section are at the head of the parade. This month they are repeating their achievement of last year when the first Engineering Progress Show, inspired and staged by junior members of the Philadelphia Engineers' Club in which ASME juniors play a prominent part, attracted more than 10,000 citizens of the Philadelphia area. The success of the show was a demonstration of what junior members of the profession can accomplish when their energy and ingenuity are directed toward a worth-while goal.

It all started in 1946 when Philadelphia juniors approached The Franklin Institute for space facilities to stage an engineering show as a service to local industry and the community. Behind the idea was the knowledge that Philadelphia citizens had few opportunities to see at firsthand the engineering developments that were taking place among them and that industry, which supported industrial fairs, rarely displayed its work to the non-engineering public. The juniors conceived the idea of an engineering progress show at which industry and the community could learn to appreciate one another. Because the idea fitted so well with the aims of the Institute of bringing science to the attention of the people, a deal was made.

Juniors then organized to put the show over. Under the chairmanship of Wayne C. Ashley, Jun. ASME, and currently vice-president of the juniors of the Philadelphia Engineers' Club, a skeleton organization began to map out sales and publicity campaigns and the broad administrative and management problems. Additional men were brought in and quickly fitted into the project as the various activities developed. The show which first seemed a sizable but not unreasonable project, turned out to be in fact a tremendous undertaking. Endless hours of hard work, constant planning, co-ordination of the efforts of many men, all of it voluntary, and the guidance of senior members of the club eventually spelled success for the project.

On Saturday, April 5, 1947, when the first Engineering Progress Show was opened, leaders of the industrial and scientific world were on hand for the ceremonies. Among these were H. P. Liverside, Fellow ASME, president, Philadelphia Electric Company, H. B. Allen, director, The Franklin Institute, officials of the City of Philadelphia, and others. During the course of the show more than 10,000 citizens visited Franklin Hall to learn what engineers and industry were doing.

This month, May 11-16, the second Engineering Progress Show, bigger and better than the first, opens its doors. Pres. E. G. Bailey has been invited to give the opening address.

In summing up the rewards for the Philadelphia juniors, R. L. Braun, Jun. ASME, who contributed to the publicity campaign, wrote, "They now have a better appreciation of what it means to form an organization to put an idea across. They also realize a keen satisfaction in seeing a task well done. They know, too, that a job well done takes a lot of doing."

Self-Management

SELF-management is one of the most difficult arts and one of the most important.[1]

Fellowships Offered

TWO-YEAR graduate fellowships in gas technology leading to a master's degree of gas technology are being offered by The Institute of Gas Technology which is affiliated with the Illinois Institute of Technology, Chicago, Ill.

The fellows will major in gas technology, but will be able to take elective courses at the Illinois Institute of Technology in a wide variety of studies. Summer employment in the gas industry is required.

Fellows will receive $125 per month for 10 months and will be exempt from tuition and fees. For additional information write to E. S. Pettyjohn, director, Institute of Gas Technology, 3300 South Federal St., Chicago, Ill.

Hydrodynamic Research

JUNIORS interested in specialized study in the field of hydrodynamics should write to the Society of Naval Architects and Marine Engineers for information on fellowships sponsored by this society at the Experimental Towing Tank at Stevens Institute of Technology, Hoboken, N. J. Fellowships to be awarded in the summer provide a year of study and practical experience in hydrodynamic research and techniques of model testing. Address: Society of Naval Architects and Marine Engineers, 29 West 39th Street, New York 18, N. Y.

Novel Meeting Procedure Devised by Detroit Juniors

IN searching for a type of educational program that would help the young engineer in coping with the nontechnical problems of his professional life, the Junior Section of the Engineering Society of Detroit in which the junior members of the ASME Detroit Section are active, came up with a good idea. In 1947 and again this year they sponsored not a series of unrelated meetings, but a course of correlated meetings called the "Personal Development Program." The novelty lies not in the correlation but in the procedure and the timing of the meetings. Because the program has been successful in stimulating interest among Detroit juniors in the activities of professional societies, the idea may be worth consideration by other junior groups.

Here is how Donald E. Jahncke, chairman, ASME Junior Committee, describes the mechanics of the Detroit procedure:

The series covers a period of four weeks. Each meeting is called to order at 8 p.m., announcements are made, and the speaker is introduced. The speaker then has from 8:15 p.m. until 9 p.m. to present his talk. At 9 p.m. the counselors, prominent engineers in Detroit who have agreed to participate in the meeting, are introduced and allowed to leave the meeting room and take up their places at tables in the dining room. Then the audience retires to the dining room where

coffee and doughnuts are served. Thus a number of small discussion groups are formed to consider what the speaker has said and to prepare questions for the ensuing question period. The counselors serve a twofold purpose. They serve to channel the thinking of the various small groups in the dining room and they also enable the younger engineers to become acquainted with a number of the more established men.

At 9:30 p.m. the meeting is called to order again in the small auditorium and for thirty minutes the speaker answers questions from the floor. At 10 p.m. the meeting is adjourned.

Junior Committee Meets

THE ASME Junior Committee is hoping to encourage 5000 of the 13,000 student members currently in the universities to transfer to the junior grade of membership. At its meeting in New York, N. Y., March 13, 1948, the Committee discussed a draft of a letter to be sent to key members in the sections, outlining the project.

The Committee's seven-point statement, suggesting Society policy on Junior Groups, was accepted without qualification by the Vice-Presidents at their meeting held in New Orleans during the 1948 Spring Meeting, it was reported. The statement will now be presented to the Regional Administrative Committee currently being held.

The statement, which was published in the April issue of the Forum, suggests that every section, regardless of size, should seek to encourage junior participation in ASME activities. Where the sections are large, organization of Junior Groups is urged. In small sections, where such groups are impractical, facilities are encouraged to promote acquaintance among the junior members.

Section Activities

Atlanta

Feb. 27, dinner meeting. Speaker: E. G. Bailey, president ASME. Subject: The Engineer's Opportunities.

Central Iowa

March 18, Grace Ranson Tea Room, Des Moines, Iowa. Speaker: J. F. McLaughlin, member ASME. Subject: Electric Power Production. Attendance: 60.

Central Pennsylvania

March 22, Engineering Building, Bucknell University, Lewisburg, Pa. Speaker: John Van Brunt, member ASME, vice-president, Combustion Engineering Company. Subject: Design of High-Pressure Steam Generators. Attendance: 75.

Cincinnati

March 4, Engineering Society of Cincinnati, Cincinnati, Ohio. Annual "Student Branch Night." Program: Sixty-six students of the University of Cincinnati ASME Student Branch attended dinner with Section members. The entire program was prepared and presented by the student branch. J. M. Klover and J. F. Bertsch were presented with a year's junior dues for their paper "Compression Characteristics of Some Common Liquids."

Cleveland

March 11, Cleveland Engineering Society, Cleveland, Ohio. Speaker: T. Keith Glennan. Subject: Some Thoughts on Engineering Education. Attendance: 150.

Columbus

March 11, Battelle Memorial Institute, Columbus, Ohio. Speakers: Nat J. Greene, president, CTC, and Gene Combs, editor, CTC News. Subjects: The Columbus Technical Council, and the Public Relations Program. Attendance: 30.

Dayton

Feb. 25, Engineers' Club, Dayton, Ohio. Six Speakers: S. R. Price, Jr., junior member ASME, manager, pump and condenser department, Ingersoll-Rand Company; W. I. Barrows, member ASME, W. I. Barrows and Associates; R. M. Shields, manager, industrial sales, Duriron Company; T. C. Monks, master mechanic of power plant, National Cash Register Company; R. F. Andres, chief chemical engineer, Frank H. Tait Station, Dayton Power and Light Company; H. P. Petzold, plant engineer, Oxford Miami Paper Company. Subject: Centrifugal Pump Forum. Attendance: 125.

March 17, Engineers' Club, Dayton, Ohio. Speaker: Dr. Victor Paschkis, member ASME, Columbia University, New York, N. Y. Subject: The Heat and Mass Flow Analyzer.

March 24, Afternoon program, Superior Engineering Division, National Supply Company, Springfield, Ohio. Speaker: John Ostborg, assistant chief engineer, National Supply Company. Subject: Diesel Engines. Evening program: Dinner and visit to plant of the Crowell-Collier Publishing Company, Springfield, Ohio, through courtesy of the Yost-Superior Company. Attendance: 90.

Detroit

March 9, Rackham Building, Detroit, Mich. Speaker: T. J. Harriman, Bell Aircraft Corporation. Subject: Advancements in Helicopter Utility and Economy. Attendance: 125.

Ithaca

Feb. 24, Cornell University, Ithaca, N. Y. Speaker: Prof. L. L. Otto, Cornell University. Subject: Design Features of New Passenger Autos. Attendance: 50.

Metropolitan

March 9, Engineering Societies Building, New York, N. Y. ASME Forum. Speaker: E. G. Bailey, president ASME. Subject: The Engineer's Opportunities. Attendance: 400.

New Haven

March 10, joint meeting of the Section and Yale ASME Student Branch, Mason Laboratory, Yale University, New Haven, Conn. Speaker: S. F. Richardson, General Electric Company. Subject: Jet Propulsion and Aircraft Gas Turbines.

North Texas

March 15, Dallas Power and Light Company Auditorium, Dallas, Texas. Program: Film on the History of Boilers, product of the Combustion Engineering Company, Inc. Attendance: 33.

Oregon

March 17, Burns' Restaurant, Portland, Ore. Speaker: Eugene Caldwell, vice-president and general manager, Hyster Company. Subject: Climbing the Steps of Management. Attendance: 55.

Philadelphia

March 16, University of Pennsylvania, Philadelphia, Pa. Speaker: Dr. W. F. G. Swann, director, Bartol Foundation. Subject: The Relation of Pure Science to Engineering. Attendance: 42.

March 17, Trenton Sub-Section, Hotel Hildebrect, Trenton, N. J. Speaker: A. L. Baker, member ASME, vice-president, Kellex Corporation. Subject: The Engineering Background in the Atomic-Bomb Development. Attendance: 57.

March 19, Engineers Club, Philadelphia, Pa. Speaker: H. C. Coleman, Westinghouse Electric Company. Subject: Turbine Electric Propulsion. Attendance: 50.

Piedmont-North Carolina

Feb. 26, Hotel Mecklenburg, Charlotte, N. C. Speaker: E. G. Bailey, president ASME. Subject: The Engineer's Opportunities. Attendance: 132.

March 6, Masonic Temple, High Point, N. C., joint meeting with the Raleigh Section, student members of State College, Duke University, and Clemson College, S. C., and the North Carolina Section, American Institute of Electrical Engineers. Inspection tour through the Tomlinson Furniture plant and the streamlined plant of the Strickland Furniture Company. Guest speaker at luncheon: Paul R. Sidler, president, Brown, Boveri Corporation, New York, N. Y. Subject: Superchargers for Diesel Engines, Gas Turbines, and Velox Steam Generators. Attendance: 100.

Rochester

March 11, joint meeting with ASCE and the Rochester Engineering Society. Hotel Sheraton, Rochester, N. Y. Speaker: Francis G. Tatnall, Baldwin Locomotive Works, Philadelphia, Pa. Subject: Making Structures Stronger by Making Them Lighter.

Following the meeting, Roy W. Hendrick, an exchange teacher at West High School, showed a color film "The Water Supply System Connecting the Colorado River Below the Hoover Dam to Southern California Cities." Attendance: 70.

St. Louis

March 26, Garavelli's Restaurant, St. Louis, Mo. Speaker: Prof. E. C. Sibley, Washington University. Subject: Problems of Personnel and the Engineer. Attendance: 40.

Southern California

March 30, junior award dinner and field trip to the Douglas Aircraft Company's plant, Santa Monica, Calif. Speaker: J. Calvin Brown, vice-president, ASME Region VII. Attendance: 115.

South Texas

March 11, The Rice Institute, Houston, Texas. Speaker: Dr. William Akers. Subject: Gas Recycling. Attendance: 20.

Syracuse

Feb. 10, Technology Club, Syracuse, N. Y. Speaker: Richard McCormick, results foreman. Subject: Boiler Feedwater Treatment. Attendance: 20.

March 8, Technology Club, Syracuse, N. Y. Speaker: Philip Swain, member ASME, editor, *Power*. Subject: Atomic Power and the Use of Words in Engineering. Attendance: 125.

Toledo

March 4, inspection of the Libbey Glass plant of the Owens-Illinois Glass Company. Attendance: 70.

Virginia

March 11, joint meeting with the Engineers Club of Virginia Peninsula, Coca-Cola Building, Newport News, Va. Speakers: W. H. Rowand, member ASME, chief engineer, and G. W. Kessler, application engineer and consultant to marine department, Babcock & Wilcox Company. Subjects: Functional Design of Stationary Boilers, and Recent Developments in Marine-Boiler Designs.

Washington, D. C.

Feb. 12, Potomac Electric Power Company Auditorium, Washington, D. C. Speaker: Fred G. Ely, member ASME. Subject: The Babcock & Wilcox Cyclone Furnace. Attendance: 83.

Western Washington

Feb. 20, Engineer's Club, Seattle, Wash. Speaker: Capt. Thomas, skipper of Coastguard Cutter *North Wind*. Subject: Operation High Jump. Attendance: 101.

March 3, Faculty Club, University of Washington, Seattle, Wash. Joint meeting with ASME Student Branch, Washington State College, to select prize papers for Northwestern Student Conference. First prize to J. MacNichol; second prize to Roger D. Olleman; third prize to Harry F. Olson; fourth prize to Ross N. Kusian; fifth prize to Robert E. Guettel. Attendance: 50.

Worcester

March 4, Worcester Polytechnic Institute, Worcester, Mass. Speaker: S. W. Quisenberry, E. I. du Pont de Nemours and Company. Subject: Color Conditioning in Industry. Attendance: 45.

Student Branch Activities

University of Akron

Feb. 26. Presiding officer: Roy R. Wiseman. Program: Movies entitled "The Cleveland Browns Football Team of the 1946 Season;" "Target for Tonight;" and "Wilbur Shaw." Attendance: 26.

March 17. Speaker: Paul Haager, assistant chief engineer, Timken Roller Bearing Company. Subject: Production and Design of Tapered Bearings. Attendance: 22.

University of Alabama

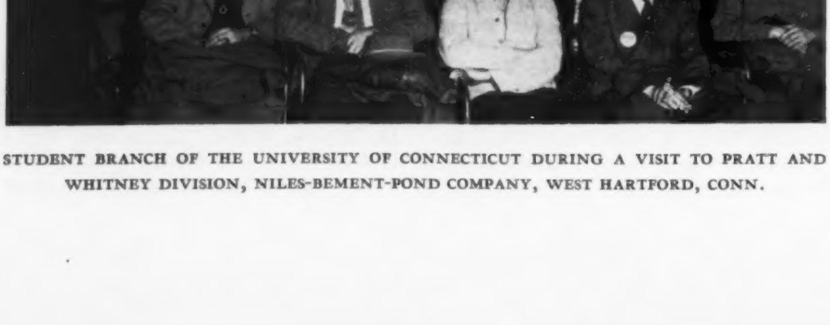
Feb. 24. Room 210A, Engineering Building. Speaker: Otto Fedor, student member. Subject: Christopher Columbus and the Engineering Problems. Attendance: 20.

University of Arizona

March 4. Administration Building. Presiding officer: Robert Brown. Program: Film entitled "Steam Progress," made by the Combustion Engineering Company, depicting the role of steam as the basic source of power and heat for the industries of America. Attendance: 30.

Bucknell University

Feb. 26. Engineering Building. Speaker: Samuel S. Fisher, Class of 1940, of the American Car and Foundry Company. Subject: New Welding Process.



STUDENT BRANCH OF THE UNIVERSITY OF CONNECTICUT DURING A VISIT TO PRATT AND WHITNEY DIVISION, NILES-BEMENT-POND COMPANY, WEST HARTFORD, CONN.

March 11. Speaker: Dr. Loren S. Hadley, director of the Guidance Center. Subject: Employment Interviews.

March 22. Speaker: John Van Brunt, member ASME, vice-president, Combustion Engineering Company. Subject: The Design of High-Pressure Vessels. John B. Clark received the ASME certificate of award in recognition of outstanding effort and accomplishment in behalf of the branch for the year 1947–1948.

California Institute of Technology

March 8. Mechanical Engineering Building. Bill Seiden and Joseph Wechsler were the winners in the speech contest for the Regional Student Convention. The first speaker's subject was "The Theory of Plastic Strain Propagation," and the second speaker's topic was "The Engineering Experience Derived From Model Building Hobbies. Attendance: 17.

Carnegie Institute of Technology

March 2. Mellon Institute. Joint meeting with the Pittsburgh Section and Pittsburgh Section student branches. Program: Symposium designed to acquaint student members with the engineer's place in research, design, manufacturing, and sales. Speakers: Dr. Blaine B. Westcott, member ASME, assistant to vice-president, Gulf Research and Development Company, Pittsburgh; A. M. Opsahl, switchgear engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa.; G. E. Richardson, assistant manager, feeder division, Westinghouse Electric Corporation, East Pittsburgh, Pa.; Francis McQuillin, industrial sales manager, West Penn Power Company, Pittsburgh, Pa. Attendance: 225.

Clarkson College of Technology

March 11. Presiding officer: Raymond Wolgast. Election of officers held. Program: Film entitled "The Story of Oil." Attendance: 60.

Clemson College

Feb. 24. Speaker: Sam C. Brown. Subject: Induction Heating. Attendance: 39.

March 9. Program: Student members C. E. Richbourg, Charles Vern, and R. S.

Frye gave talks on "Photoelasticity and Its Application to Stress Analysis." Attendance: 52.

March 23. Speaker: Clyde Thompson, student member. Subject: Heat Pump. Guest speaker: J. C. Harris, group engineer, Deering-Milliken Textile Mills. Subject: Air-Conditioning Units. Attendance: 40.

Colorado A&M College

Feb. 16. Mechanical Engineering Building. Program: Motion picture "Radio Frequency Heating." Attendance: 37. At a later meeting Prof. J. T. Strate, member ASME, gave a paper entitled, "What Every Engineer Should Know," written by Weller Embler. Attendance: 40. The third meeting featured a Continental Oil Company film entitled "Conoco Oil Plating." Attendance: 54.

Columbia University

March 12. Room 208, Pupin. Meeting of Mechanical Division. Speaker: D. B. Steinman. Subject: Aerodynamics of Bridges. Attendance: 110.

University of Connecticut

March 11. Field trip to the plant of the Niles-Bement-Pond Company, Pratt and Whitney Division, West Hartford, Conn. Attendance: 26.

Cooper Union (Day)

March 10. Presiding officer: Carl Zimmer. Speaker: Howard Silfin, a junior in the school of engineering. Subject: The Problems of Coke-Oven Design. Attendance: 24.

Cornell University

March 9. Sibley Hall. Speaker: Dr. Clifford C. Furnas, director of the Cornell Aeronautical Laboratory, Buffalo, N. Y. Subject: The Cornell Aeronautical Laboratory. Attendance: 30.

March 23. Sibley Hall. Program: Two Films, "Tornado in a Box," product of Allis-Chalmers Manufacturing Corporation; and "Panorama of Alloy Steels," product of the Climax Molybdenum Company. Attendance: 50.

University of Detroit

Feb. 25. Commerce and Finance Building. Speaker: W. M. Scranton, junior member ASME, liasion officer of the Detroit Junior Section, ASME. Subject: Lifework of the speaker, and how he happened to reach his present position with the Ford Motor Car Company. Program: Two travelogue films produced for the Dodge Motor Company, "Strategic Materials," and "Wheels Across Africa." Attendance: 75.

Georgia School of Technology

March 4. Inspection tour by five senior-engineering branch members to plant of the Union Bag & Paper Corporation, Savannah, Ga. Tour arranged by Dan E. Kehoe, chairman of the student-branch committee, ASME.

George Washington University

March 3. Govt. 1, Presiding officer, Herbert H. Murray. Program: Competitive talks by student members. Elmer Sunday, winner of contest, received a handbook of his choice, and represented the University at the Regional Conference in April. Attendance: 55.

Illinois Institute of Technology

Feb. 27. North Student Union. Presiding Officer: Rudolf Hempel. Speaker: Dr. R. A. Budenholzer, junior member ASME. Subject: Discussion of coming local and national ASME essay contests. Attendance: 70.

University of Idaho

Feb. 8. Kirtley Laboratory. Group picture taken for the yearbook.

March 8. Plans made for ASME convention to be held jointly with Washington State College, May 5 to 8.

March 22. Program: Film entitled "Modes and Motors."

Johns Hopkins University

March 5. Speaker: Rudolph Michel of the Navy's Bureau of Ships. Subject: Choice of a Steam Cycle for the Propulsion of High-Speed Surface Vessels.

March 6. Room 109, Maryland Hall. Special social meeting with dancing. Attendance: 20 couples.

University of Kansas

March 6. Presiding officer: Steve Hadley. Program: Four papers presented to determine the winner who will present his paper before a joint meeting of the Kansas City, Lawrence students, and Kansas State student members, ASME. James D. Warner, "A Brief Adventure Into Automobile Air-Conditioning." Charles H. Green, "High-Temperature, High-Pressure Piping Layout Stress Analysis." John C. Sells, "Fuel Injection Systems for Diesel Engines." James T. McKinney, "The Heat Pump for Year-Around Air Conditioning." Attendance: 35.

March 11, Training School Auditorium. Speaker: Miss Chloe Gifford, president, Kentucky Federation of Women's Clubs. Subject: Discussion on The United Nations.

University of Kentucky

March 25. Training School Auditorium. Presiding officer: J. L. Morrissey. Program: Two nontechnical movies, "Let's Go Fishing," and "Hot Ice."

Lafayette College

March 4. Speaker: W. H. Jackson, Babcock & Wilcox Company. Subject: Steam Power for American Sea Power, discussed and illustrated with a sound motion-picture film. Attendance: 50.

University of Michigan

March 3, 4, and 5. Visits to the Ecorse plant of the Great Lakes Steel Corporation to view some of the facilities and the general operation of the plant. Attendance: 100.

March 17. Room 321, Michigan Union. Speaker: M. R. Fox of Vickers, Inc. Subject: Application of Hydraulics in Industry. Attendance: 50.

March 24. Room 229, West Engineering Building. Speakers, Student members: Leonard Cohen, paper on "Development of Sheet-Metal Working;" Russel Parkinson, Jr., paper on "Development of the Small-Arms Design;" Munjandira Somaya, paper on "Design Trends for the Future Indian Market in Diesel Engines." Attendance: 28.

Missouri School of Mines & Metallurgy

Feb. 12. Parker Hall. Presiding officer: J. W. Wallace. Program: Color films on tuna fishing, salmon fishing, and tarpon fishing. Attendance: 85.

Feb. 25. Parker Hall. Joint meeting with AIEE. Speaker: R. N. Slinger, application engineer, apparatus division, General Electric Company. Subject: Frontiers in Engineering. Attendance: 95.

March 9. Parker Hall. Speaker: James W. Owens, technical assistant, Fairbanks Morse and Company, Beloit, Wis. Subject: Progress and Development of Welding in the U. S. Attendance: 70.

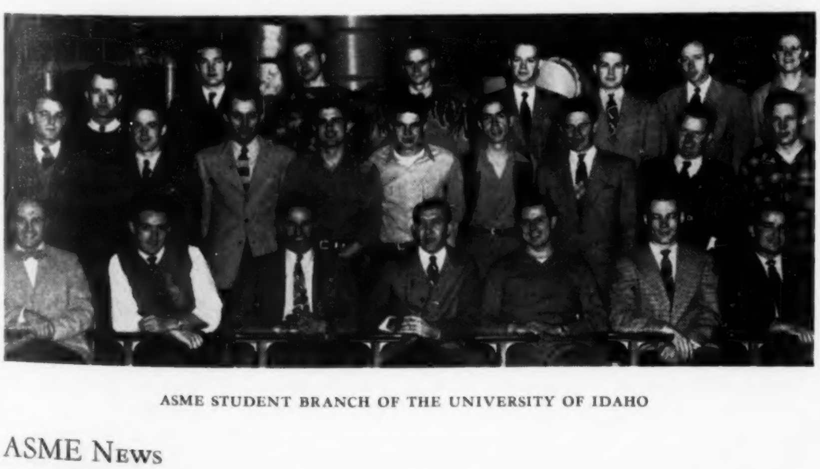
March 23. Parker Hall. Speaker: Paul Brant, Reynolds Manufacturing Company. Subject: History of the Aluminum Industry, illustrated with a film on the production of aluminum. Attendance: 70.

College of the City of New York

March 4. Doremus Hall. Speaker: Bertram H. Saltzer, engineering services administrator, Wright Aeronautical Corporation. Subject: What Industrial Employers Look for in a Prospective Engineer, and Vice Versa.

March 11. Speaker: Merrill C. Horine, sales promotion manager, Mack-International Motor Truck Company. Subject: Salesmanship in Engineering.

March 18. Doremus Hall. Speaker: Carl



ASME STUDENT BRANCH OF THE UNIVERSITY OF IDAHO

ASME STUDENT BRANCH OF THE UNIVERSITY OF MICHIGAN DURING VISIT TO GREAT LAKES STEEL CORPORATION, ECORSE, MICH.

E. Habermann, Socony-Vacuum Oil Company. Subject: The Efficient Production and Utilization of Motor Gasoline. This paper was discussed by Mr. Habermann, but the author was W. M. Holaday, director of the Socony-Vacuum Laboratories.

March 25. Presiding officer: Franklin Cohn. General business meeting. Attendance: 100.

April 1. Joint meeting with SAE. Speaker: Mr. Voss of the Special Devices Center of the Department of Naval Research. Subject: Some Aspects of Human Engineering. Attendance: 100.

University of Nebraska

March 11. Richards Laboratory. Speaker: R. G. Gustavson, chancellor of the University. Subject: Atomic Energy. Attendance: 175.

North Carolina State College

Feb. 24. 100 Page Hall. Presiding officer: A. W. Futrell. Officers for the coming year were elected. Attendance: 60.

North Dakota Agricultural College

Feb. 12. Engineering 22. Election of officers. Program: Film entitled "Snow Time in Canada." Attendance: 22.

Feb. 26. Engineering 22. Speaker: Dr. Pye. Subject: The Petroleum Industry. Attendance: 17.

March 10. Discussion on Economics in Engineering, led by Dr. Petty. Attendance: 21.

University of North Dakota

Feb. 25. Chandler Hall. Program: Speeches by student members in competition for a student-branch prize, and to determine the speaking representative to the national convention. Attendance: 21.

March 17. Chandler Hall. Roger Madson, presiding officer. General business meeting. Attendance: 29.

Northeastern University

March 4. ASME room, Richards Hall. Presiding officer: Mathew Reiser. Program Film entitled "The Art of Generating and Gear Manufacture," product of the Fellows Gear Shaper Company. Attendance: 55.

March 18. ASME room, Richards Hall. Speaker: Harry E. Williams, Diesel engineer for General Motors Company, connected with the Yellow Truck and Coach Division. Subject: Principles of the Diesel Engine and Application of the Engine in Public Conveyances. Attendance: 49.

Northwestern University

Feb. 27. Tech Building, LR 2. Meeting of members, their wives, and friends. Speaker: Axel A. Hofgren, Critton, Schroeder, Merriam and Hofgren, law firm. Subject: What the Engineer Should Know About Patents and Patent Law. Attendance: 60.

Oklahoma A&M College

Feb. 23. Room 302, Engineering Building Presiding officer: Leroy W. Ledgewood. Program: Two papers by student members. First, George Lange, "High-Frequency Heating." Second: Leon Britts, "Alfalfa Dehydration." Attendance: 35.

March 8. Engineering Auditorium. Program: Preview of "Steam Progress," film produced by Combustion Engineering Company, Inc. Attendance: 100.

March 22. Engineering Auditorium. Speaker: W. J. Overton, Emerson-Overton Employment Agency, Tulsa, Okla. Subject: How to Apply for a Position With a Firm of Your Choice. Attendance: 58.

University of Oklahoma

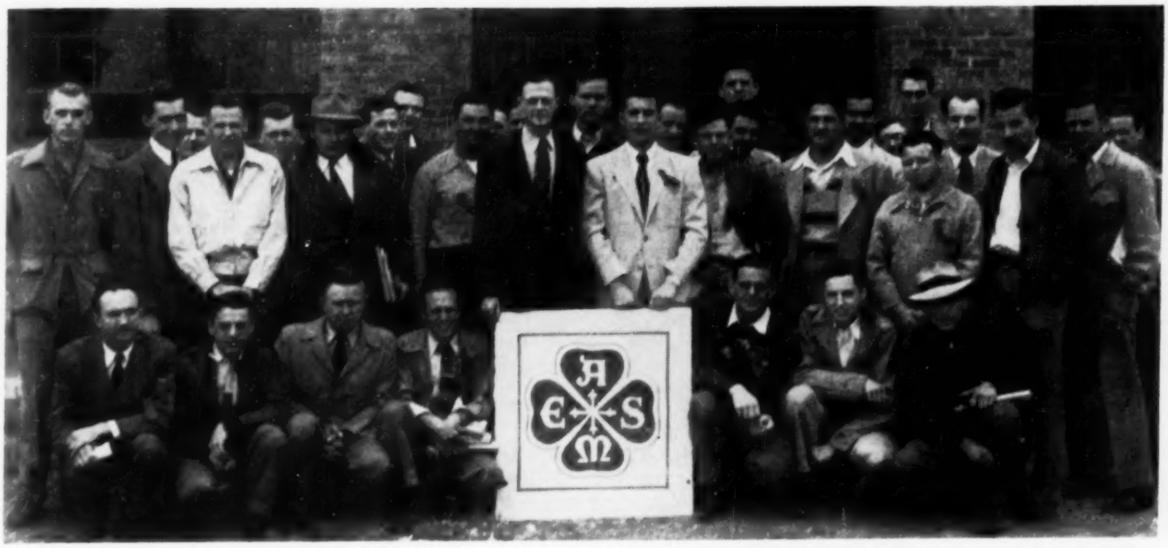
Feb. 25. Engineering Auditorium. Presiding officer: Charles J. Mauck. Speakers: D. E. Foster, member ASME, and Mr. Carter of Dowell, Inc. Subjects: International Petroleum Exposition to be held in Tulsa May 15 to 22; and talk on the Dowell, Inc.'s activities in this area. Program: Lieut. Comdr. St. Pierre presented a film entitled "Operation Crossroads." Attendance: 75.

March 9. Engineering Auditorium. Presiding officer: Charles J. Mauck. Speaker: D. F. Bennett, Warren Webster & Company. Subject: Baseboard Heating. Attendance: 60.

March 12 and 13. Annual student paper competition of the Mid-Continent Section, ASME. First prize of $50 to Charles J. Mauck, chairman of the U of O student branch, ASME, for his paper "Dual-Fuel-Diesel—Performance and Application." A $10 fourth prize was awarded to P. M. Rubins, mechanical-engineering senior for his paper

ASME STUDENT BRANCH, PURDUE UNIVERSITY, BANQUET IN HONOR OF R. J. SHONT, CHIEF ENGINEER, PROCTER AND GAMBLE COMPANY

(*Seated left to right:* B. R. Thomas, R. S. Hailt, D. S. Clark, W. T. James, R. J. Shont, D. E. Cooley, A. E. Cooper, J. L. Evert, C. F. Warner, R. I. Eddy, C. H. Nichols, H. A. Bolz, M. Nasser, H. L. Solberg, D. R. Copple, A. S. Hall, F. L. Cason.)



ASME STUDENT BRANCH OF THE TEXAS TECHNOLOGICAL COLLEGE

"Mechanical Engineering in the Modern Home." A dinner on March 12 was followed by an address by Dr. J. T. Rettaliata, member ASME, chairman, department of mechanical engineering, Illinois Institute of Technology, entitled "Development of the Gas Turbine and the Jet Engine." Inspection trips were made through the W. C. Norris Manufacturing Company's and Carter Oil Company's research laboratories.

Oregon State College

Feb. 11. Chemistry 201. Speaker: Donald Kroeker, consulting engineer, of Portland, Ore. Subject: The Workings of the Heat Pump. Attendance: 275.

Feb. 26. Speaker: Jim Judson, OSC graduate of 1934, now employed by the Eugene Water Board. Subject: Steam-turbine power installation run by his company.

Feb. 28. Inspection by 35 members of the steam-turbine power plant run by the Eugene Water Board, Eugene, Ore.

Pennsylvania State College

March 25, 107 Main Engineering Building. Student paper contest. First prize of $10 to William McKim, for his paper "A New Mechanical Principle—Ring Springs." Second prize of $5 to George Hileman for his paper "Centerless Thread Grinder." Third and fourth prizes were awarded respectively to Mary Ilgen for her paper "Applications of Simplified Construction to Light Plane Production," and to David Landig for his paper "Metalizing as a Production Process." Attendance: 30.

University of Pittsburgh

March 4. Cathedral of Learning. Speaker: Dr. M. C. Elmer, head of the sociology department at the University. Subject: "Population and Its Trends. Attendance: 149.

March 18. Cathedral of Learning. Speaker: James E. Knarr, director of industrial relations, Columbia Steel and Shafting Company. Subject: Human Engineering. Attendance: 147.

Princeton University

March 18. Engineering Lounge. Speakers: Mr. Aicher and Mr. Pollard, both from the Yarnall-Waring Company, Philadelphia. They explained their film "There Is an Engineering Reason," and demonstrated plastic models of a new water-level indicator. Attendance: 54.

Purdue University

March 2. Mechanical Engineering Building. Joint meeting with student branch of AIEE. Speaker: R. J. Shont, chief engineer, Procter and Gamble Company. Subject: What Industry Expects of the Engineering Graduate. Attendance: 202.

Rutgers University

Feb. 25. Engineering Building. Speaker: A. M. Marin, Council of Western Electric Technical Employees. Subject: "The Economic and Professional Status of Engineers in Industry. Attendance: 30.

Stevens Institute of Technology

Feb. 50. Speaker: Ole Singstad, consulting engineer, told of his part in the digging of New York City's many underwater vehicular tunnels. Attendance: 50.

Feb. 17. Inspection trip to the Dumond Television plant, Clifton, N. J.

Feb. 26. Speaker: P. N. Shoemaker, vice-president, Lackawanna Railroad. Subject: Railroading and the Mechanical Engineer. The following week the branch members, as guests of the Lackawanna, made an inspection tour of the Lackawanna Terminal in Hoboken, N. J.

Feb. 20. Joint meeting with the Metro-

ASME STUDENT BRANCH OF WASHINGTON STATE COLLEGE

politan Council of student branches. Officers elected for the coming semester.

Swarthmore College

Feb. 19. Martin Hall. Engineers Club meeting sponsored by the branch. Speaker: George P. Morgan, personnel director of the Lester, Pa., plant of Westinghouse Electric Corporation. Subject: Personnel Policy of the Lester plant; with statistical information obtained from a quarterly report prepared by the office of the company. Attendance: 35.

March 25. Martin Hall. Speaker: Otto de Lorenzi, Fellow ASME, director of education, Combustion Engineering Corporation. Subject: A Study of Stoker Fuel Beds. Attendance: 100.

University of Tennessee

Feb. 4. Estabrook Hall. Presiding officer: Gene Holthofer. Program: Film of the Jenkins Valve Company. Mr. McCleary, area representative of the Jenkins Company, held a discussion after showing of the film.

Feb. 19. Speaker: N. W. Bowden, Tennessee Valley Authority. Subject: Reservoir Operation, illustrated with slides.

March 4. Speaker: Paul Kofmehl, head of the research-engineering department, Clinton Laboratories, Oak Ridge, Tenn. Subject: Pressure Vessels and Their Manufacture. Attendance: 18.

Texas Technological College

March 17. Engineering Building. Laying of a bronze ASME plaque in the arcade of the engineering building on St. Patrick's Day, in keeping with an annual tradition started in 1936.

University of Texas

March 10. Geology Building Auditorium. Joint meeting with the AIChE. Speaker: Otto de Lorenzi, Fellow ASME, director of education, Combustion Engineering Company, Inc., New York, N. Y. Subject: Furnace for By-Product Fuels. Attendance: 35.

Tufts College

March 10. Robinson Hall. Speaker: Prof. F. Alexander Magoun, head of the department of humanics, Massachusetts Institute of Technology. Subject: Methods Used by Good Job Interviewers. Attendance: 109.

March 23, trip to Mystic Station of the Boston Edison Company. Attendance: 27.

Virginia Polytechnic Institute

March 2. Building 365. Program: Talks by student members. First, Paul Duckworth, "The Voith Schneider Marine Propeller." Second: Lewis Lichtenstein, "Teaching." Third, R. H. Clift, "The Tucker Automobile."

March 30. Building 365. Presiding officer: W. G. Boggs. Program: Showing of a Socony-Vacuum Company film, "The Inside Story of Lubrication." Attendance: 165.

Washington State College

Feb. 11. Mechanical Arts Building. Program: A film entitled "Steam Power and American Sea Power." Attendance: 19.

Feb. 25. Speaker: Mr. Thraidquill, Washington Water Power Company. Subject: Engineering as a Profession. Attendance: 60.

March 10. Mechanical Arts Building. Speaker: Mr. Tantlantur, chief engineer, Brown Industry, Spokane, Wash. Subject: Fabrication Methods of Monocoque Trailers, illustrated with slides. Attendance: 30.

University of Washington

March 3. Faculty Club. Student engineering papers were presented at a joint dinner meeting of the senior and student members. First place was awarded to James MacNickols for his paper "The Possible Use of Ceramics for Gas-Turbine Parts." Second place to Roger D. Olleman, for his paper "Trends in Engineering Education." Attendance: 50.

Wayne University

March 4. Webster Hall. Speaker: Ernest J. Abbott, member ASME, president and general manager, Physicists Research Company, Ann Arbor, Mich. Subject: The Profilometer. Attendance: 38.

University of Wisconsin

March 9. Speaker: Harry W. Highriter, Vascoloy-Ramet Corporation. Subject: Powder Metallurgy. Attendance: 22.

University of Wyoming

March 16. Engineering Building. Program: Papers by student members in competition for cash prizes donated by members of the mechanical-engineering faculty. First, Mason Barlow, Jr., "Testing and Adjusting for Air-Conditioning Systems." Second, E. F. Rasmussen, "The Heat Pump." Third, Keith Robertson, "The Weldability of Ferrous Metals by the Arc Process." Honorable mention to Gene Binning for his paper "History and Development of Air Conditioning." Attendance: 44.

Yale University

Feb. 25. Mason Laboratory. Joint meeting with ASCE student branch. Speaker: A. T. Waidelich, assistant director of research, The Austin Company. Subject: Talk on trend of structural design to incorporate the latest advances that have led to the development of the controlled-conditions plants, illustrated with slides and motion pictures. Attendance: 120.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3.50 per quarter or $12 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	211 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

PRODUCTION-PLANT ENGINEER, age 30, 9 years' experience production and design. Experience parts assembly, machine shop, sheet metal. Desires permanent responsible position in production or plant engineering. Me-289.

BUSINESS ENGINEER, age 25, Stevens ME. Presently employed. Experienced in job-cost estimating, proposal writing, and business procedures, together with related work in purchasing and standard costs. Desires administrative work in New York City. Me-290.

INDUSTRIAL ENGINEER, degree, 25 years' experience methods, layout, materials handling, incentives, time study, budgets, training, job evaluation, cost reduction, investigations, reports, and supervision. Skilled with labor. Capable organize and administer programs in industrial-engineering cost reduction, training, wage-and-salary administration. Me-291.

MECHANICAL PROFESSIONAL ENGINEER, desires west coast position in sales engineering. Many years' experience in combustion control, feedwater control, pressure-reducing and desuperheating systems, and instrumentation. Executive or management position considered. Me-292.

MECHANICAL ENGINEER, BSME, age 29, experience in machine shop, design and detail of automatic machinery, and supervision of engineers and mechanics. Me-293.

MECHANICAL ENGINEER, age 26, married, four and a half years' general experience in the engineering, manufacture, and application of electrical equipment. Desires position

(*ASME News Continued on page 498*)

[1] All men listed hold some form of ASME membership.

Yarway Unit Tandem Blow-Off Valve combining the Yarway Seatless Valve (for sealing) and the Yarway Hard-Seat Valve (for blowing) in a one-piece forged steel body. For pressures up to 2500 psi.

with small company as development, industrial, production, or application engineer. Me-294.

MARKETING ENGINEER, age 34, mechanical-engineering and business-administration degrees, with experience to analyze markets, establish best method of distribution, evaluate and load sales organization, train salesmen, plan special-product promotion. Me-295.

MECHANICAL ENGINEER, age 30, Tau Beta Pi, currently employed preparing operational manuals for plastics-fabricating machinery. Machine-shop experience. Seeks plant-engineer position in small shop, preferably small town. Me-296.

POSITIONS AVAILABLE

RECENT GRADUATE, mechanical, interested in chemistry and chemical engineering; no industrial experience necessary; with aptitudes in design and production problems, for powder-metals pressing field. Pennsylvania. Y-547.

ENGINEERS. (*a*) Chief engineer, mechanical graduate, with precision-tool and die experience, to take charge of engineering for steel-products manufacturer. $10,000. (*b*) Junior mechanical engineer with machine-shop experience, to assist in improvement of production methods. $3600–$4800. Upstate New York. Y-557.

TEACHING PERSONNEL for mechanical-engineering department, to teach the following subjects: industrial engineering; materials testing; internal-combustion engines; refrigeration and air conditioning; machine design; and fluid mechanics. Advanced degrees desirable, but interest in teaching and professional experience will be considered. Position will range in rank from full professors at $5100, to instructors at $2760 for 10 months' service. New England. Y-563.

ENGINEERS. (*a*) Junior mechanical, engineer, recent graduate, who is interested in mechanical design and general plant engineering. (*b*) Junior electrical, mechanical, or ceramic engineer who is interested in experimental and production-control work on special glass products. Tennessee. Y-567.

PRODUCTION SUPERVISOR, mechanical graduate, with small spring-design and production experience, to take charge of installation of equipment, and placing in operation spring-wire forming machinery. Salary open. Central New York State. Y-569.

MECHANICAL ENGINEER, 35, with 5 or 6 years' experience in industry. Should have experience on modern up-to-date boiler installations. Will be responsible for supervision and operation of such equipment on an economical basis; and will aid in the supervision of evaporating equipment. Write stating personal, educational, and experience data. Upstate New York. Y-578.

INDUSTRIAL ENGINEER, 38–45, graduate, to head up industrial-engineering department. Should have had 8 to 10 years' experience in heading up such a department. Should also have had some experience negotiating standards with unions, wage incentive, etc. $8000–$10,000. Northern New Jersey. Y-585.

CHIEF ENGINEER, 38–45, mechanical graduate, for builders of pulp and papermaking machinery. Should be familiar with pulp and papermaking machinery, but this is not a prerequisite. Must have administrative ability. Salary dependent upon ability and experience. Wisconsin. Y-587-C.

PLANT ENGINEER, 35–45, mechanical graduate, with textile-mill experience, to supervise steam power plant, maintenance of plant and machinery, construction, etc. Knowledge of new textile electronic controls desirable. $7000. Pennsylvania. Y-594.

MECHANICAL-DESIGN DRAFTSMAN, 35–45, for layout work and with some experience in piping, light structures, and power work for food-processing plant. Will make drawings, prepare specifications, cost estimates, and follow job through to completion. $3900. Upstate New York. Y-598.

DESIGN ENGINEER, 30–40, mechanical or electrical for design and development of domestic electric ranges. Should have some experience in fabricating vitreous-enamel products, and experience in heating-element and switch design. Duties will be to develop new ideas, features, and structural elements of new model ranges, and will have the responsibility of shop contact with tool design, manufacturing, etc., in connection with this design and development work. Starting salary, $5200. Ohio. Y-602.

ENGINEERS. (*a*) Mechanical-design engineer, experienced, with Army-Navy and Navy specifications, together with a good knowledge of materials. (*b*) Mechanical engineer, experienced, who has worked with electronic and radar instruments, particularly computers. An electrical engineer could qualify for this position. (*c*) Mechanical engineer, who would work with (*b*), but would not be required to have as much experience. A young man interested in research work would qualify. $4000–$6000 depending on experience. Westchester County, N. Y. Y-606.

PRODUCTION MANAGER, 40–45, mechanical degree, for a plant building heavy machinery. Should be capable of handling production control, department personnel, material routing, and internal transportation, as well as being thoroughly qualified in modern production techniques. East. Y-607.

MECHANICAL DRAFTSMAN with 1 to 3 years' experience in structural and heavy-machinery-maintenance drafting. $4800 plus transportation. Alaska. Y-611.

PLANT ENGINEER, mechanical, with experience in rubber rolling-mills maintenance, Baker Perkins mixers, stills, pumping equipment, powerhouse, electric power and motors, buildings, rolling-stock electric trucks, products of high fire risks. Will have full mechanical responsibility for all equipment upkeep and economical operation from engineering point of view. Safety of all workers, and mechanical hazards affecting all other workers; ability to make accurate engineering drawings, capable of calculation of costs on his department's work. Northern New Jersey. Y-621.

PLANT ENGINEER, 30–40, mechanical graduate, with 5 to 10 years' experience, covering steam power plant, pumping, refrigeration, to supervise maintenance in brewery. $5000–$6000. Metropolitan area. Y-628.

MECHANICAL ENGINEER for detail and design work on ore bridges, cranes, and whirlers. Prefer man with 5 to 10 years' detail and design experience in heavy materials-handling equipment and one who is capable of rapid and accurate work under general supervision. Write stating personal data, education, and experience, and business references. Pennsylvania. Y-654.

TEACHING PERSONNEL. (*a*) Associate professors, capable of organizing and teaching junior and senior machine design and allied courses. Should have considerable professional attainments, advanced academic work, and actual engineering experience. $4100–$5000. (*b*) Assistant professors, capable of teaching basic engineering subjects. Chief interest should be in the field of machine design. Advanced academic work required. Engineering experience desired. About $3700. (*c*) Instructor in mechanical engineering, recent graduate, with master's degree. About $3000. Upstate New York. Y-676.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after May 25, 1948, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt. & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

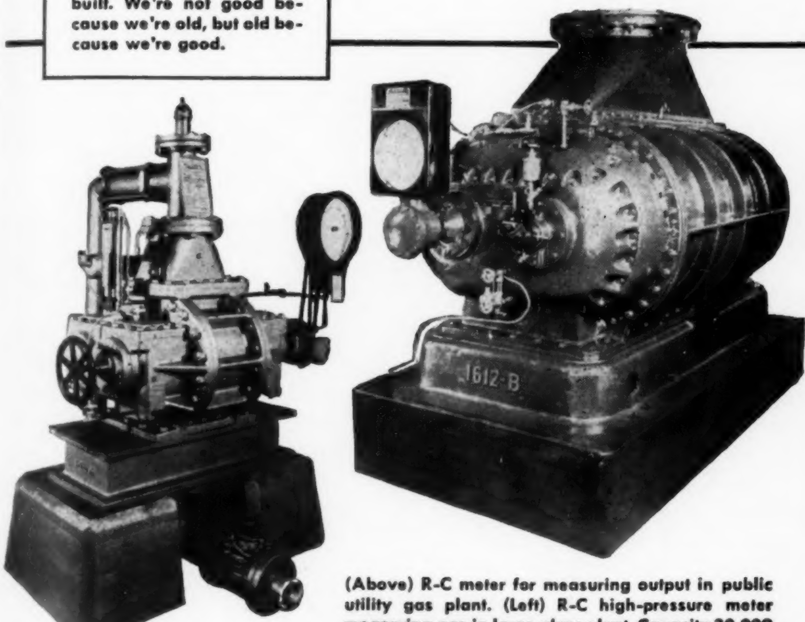
For Member, Associate, or Junior

ALIM, SITAL P., Berkeley, Calif.
ANDERSON, FLORENCE B., Winnetka, Ill.
ANDERSON, PAUL E., Downey, Calif.
ATKINSON, JOHN E., Brooklyn, N. Y.
AVERELL, ANSEN MAYO, Berkeley, Calif.
BARROW, DAVID N., Shreveport, La.
BASSEL, JOHN B., Florence, Ala.
BAUM, MELVILLE R., Birmingham, Ala. (Rt & T)
BECKER, JOHN C., JR., Alhambra, Calif.
BEER, WILLIAM B., Coraopolis, Pa.
BELL, PHILLIP ALFRED, Jackson, Mich.
BERRY, JOHN M., Indianapolis, Ind.
BHEDI, VITHAL GOVIND, Madras Presidency, India
BLOSSOM, LYLE REX, Detroit, Mich.
BOHR, ALEXANDER H., Dover, N. J.
BROWN, RALPH THOMAS, Chicago, Ill.
BRYAN, RALPH DAY, La Grange, Ill.

(*Continued on page 500*)

George M. Pullman's first sleeping car went into service in 1859, five years after the first Roots Blower was built. We're not good because we're old, but old because we're good.

Measure INPUT OR OUTPUT WITH CASH REGISTER *Accuracy*



(Above) R-C meter for measuring output in public utility gas plant. (Left) R-C high-pressure meter measuring gas in large glass plant. Capacity 30,000 CFH for continuous load and 45,000 CFH for 1-hour peak load.

Wherever gas needs to be measured . . . for buying, selling or processing . . . you get unfailing accuracy from R-C Positive Displacement Meters. The reasons are:

1. Accuracy is not affected by variations in specific gravity, rate of flow, pulsation, moisture or impurities.
2. Accuracy does not depend on uncontrollable factors.
3. Accuracy is not subject to adjustment of meter or recorder by operators.
4. Accuracy is not affected by reasonable overloads.
5. Accuracy is permanent because measuring chambers are surrounded by precision-machined, cast-iron surfaces.

The wide use of R-C Meters by public utilities, producers, industrial users and processors is the best evidence of satisfactory performance. For details, ask for Bulletin 40-B-14 or write us about your specific problem.

ROOTS-CONNERSVILLE BLOWER CORPORATION
805 Michigan Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE
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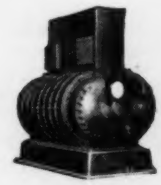
BLOWER BUILDERS · R-C · SINCE 1854
BLOWERS · EXHAUSTERS · BOOSTERS · LIQUID AND VACUUM PUMPS · METERS · INERT GAS GENERATORS

* * ONE OF THE DRESSER INDUSTRIES * *

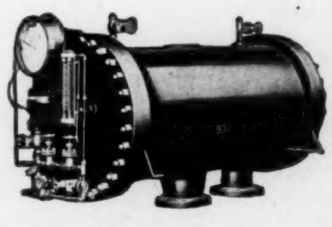
WIDE VARIETY OF R-C METERS FOR INDUSTRIAL USES

R-C Meters are available in 31 standard sizes, for maximum working pressures of 25 lbs., 50 lbs. and 125 lbs., and for capacities from 4,000 to 1,000,000 CFH. Meters for higher pressures or other unusual requirements can be adapted from standard units or built to the user's needs.

(Left) This 2½" x 7" meter has an inclined differential gauge, with top inlet, and outlet in bedplate.



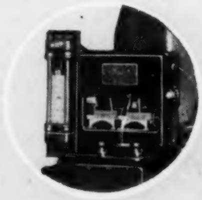
(Right) Large size low-pressure meter, with side inlet box, bottom outlet and P.V.T.T. Recorder.



(Above) Special high-pressure meter, for line pressures of 300 lbs. and up.

ACCESSORIES FOR R-C METERS

Many types of recorders and integrators are available for R-C Meters. They enable users to compile records for practically every phase of metering operations, for almost any unit of time.



R-C Meter equipped with pressure and temperature integrator which corrects for both pressure and temperature.

Campbell, James W., Detroit, Mich.
Carlson, Carl J., Avenal, Calif.
Chabot, Richard C., Chattanooga, Tenn.
Clemens, Ogden Aaron, Jr., Chicago, Ill.
Cohen, Samuel S., Milwaukee, Wis.
Cook, Barton B., Jr., Manhasset, L. I., N. Y.
Cook, William H., Baltimore, Md.
Cocke, Russell Andre, Kingsport, Tenn.
Cornelius, Theodore, New York, N. Y.
Coultas, Robert M., Erie, Pa.
Cox, Robert W., Dallas, Texas
Denlinger, John F., Dayton, Ohio
Dietrich, Louis R., Lacey, Wash.
DiPietro, Frank Anthony, Wilmington, Del.
Dodson, John Lewis, Philadelphia, Pa.
Dove, John F., Chicago, Ill.
Dunn, Raymond E., Martinez, Calif.
Ellicott, Charles R., Jr., New York, N. Y.
Ericsson, Gunner, Philadelphia, Pa.
Felty, John A., Greensburg, Pa.
Fooks, Ruper J., Denver, Colo.
Gilbreath, Warren D., LaGrange, Ill.
Gilliam, Louis C., Jr., Corpus Christi, Texas
Gladney, David C., Wilmington, Del.
Gompertz, Richard F., Dayton, Ohio
Goodwin, John H., San Francisco, Calif.
Graumann, Raymond L., Silver Spring, Md.
Gray, Emerson G., High Point, N. C.
Hanley, Frank, Chicago, Ill.
Hasse, Robert W., Akron, Ohio
Hausman, Laurence, Merrick, L. I., N. Y.
Heyes, Gordon Ellsworth, Baltimore, Md.
Hitchcock, George M., Cumberland, Md.
Hoff, Milton A., Lancaster, Pa. (Rt & T)
Hume, Benjamin G., Sunland, Calif. (Rt & T)
Jansen Van Vuuren, P., Johannesburg, S. A.
Jedrey, Jedrzejowski Wieslaw, Chicago, Ill.
Johnson, Walter Stuart, Los Angeles, Calif. (Rt & T)
Kahl, Fritz O., Corning, N. Y.
Kalelkar, Bal Dattatrey, Wardhal, India
Keilman, Clarence J., Valley Stream, N. Y.
Kerr, A. W., Chicago, Ill.
Kessler, John, Jr., Morrisville, Pa.
Knowlton, Chase H., White Plains, N. Y.
Koehler, Louis Adam, Jr., Baltimore, Md.
Kogel, Frank J., Burbank, Calif.
Koost, Arvid, Thorold, Ont., Can.
Kraujalis, Felix S., Chicago, Ill. (Rt & T)
Landry, Max E., Tulsa, Okla.
Lannom, Edward H., Jr., Savannah, Ga.
Lautz, William H., Torrington, Conn.
Leavengood, William Harry, Savannah, Ga.
Link, John B., Alhambra, Calif.
Lonnecker, George V., Waterloo, Iowa (Rt & T)
Luigi, Marzoll, Brescia, Italy (Rt & T)
Malik, Abdul, New York 27, N. Y.
Market, Wallace, Jr., Alliance, Ohio
Mattox, William Addison, 3rd, Webster Groves, Mo.
May, Alonzo, Mission, Kan.
McCarthy, Frank W., Brooklyn, N. Y.
McCarthy, John F., Arlington, Mass.
McClain, John N., Chattanooga, Tenn. (Rt & T)
Medwed, Peter M., Brooklyn, N. Y.
Merritt, Paul Grenville, New Orleans, La. (Rt & T)
Miano, Salvatore V., Brooklyn, N. Y. (Rt & T)
Morgan, Berney L., Philadelphia, Pa. (Rt & T)
Morris, Edward Jerome, Baltimore, Md.
Morris, James R., Woodbury, N. J.
Morton, Fred C., Savannah, Ga.
Mueller, Elmer J., Memphis, Tenn.
Murphy, Eugene A., Jr., Philadelphia, Pa. (Rt & T)
Nargi, John Joseph, Los Angeles, Calif.
Newman, Louis E., Marblehead, Mass.
Novak, Edward A., Chicago, Ill.
Parsons, Norman G., Alplaus, N. Y.
Peasley, Roward P., Erie, Pa.
Price, William O., Devon, Pa.
Pritzker, Robert A., Chicago, Ill.
Proctor, Harvey A., Los Angeles, Calif.
Rogers, Robert E., Jr., Glendale, Calif. (Rt)
Rom, Frank E., Ithaca, N. Y.
Salters, Nicholas, Mt. Vernon, N. Y.
Sammut-Smith, Anthony, London, England
Saunders, Robert Neal, Ambridge, Pa.
Schultz, Larry, Albany, Calif.
Scott, Charley, Meridian, Miss.
Seanor, Rex G., Akron, Ohio
Sherwood, Ellsworth, Scarborough, N. Y.
Sloane, Maurice I., Dunkirk, N. Y.
Smurthwaite, P. M., Kenmore, N. Y.
Sollenberger, R. Clem, Washington, D. C. (Rt & T)
Specht, Robert A., New York, N. Y.
Stevens, Howard, Plainfield, Iowa
Stuermer, Paul J., Chicago, Ill. (Rt)
Swain, Paul A., DeKalb, Ill.
Thelander, Oliver H., Chicago, Ill.
Thornburg, Robert Wentworth, Minneapolis, Minn. (Rt & T)
Tivy, Vincent, Foxboro, Mass.
Townsend, John R., Murray Hill, N. J. (Rt & T)
Travis, A. D., Dallas, Texas
Turnbull, William G., Toronto, Ont., Can. (Rt & T)
Wages, Clarence J., Sr., Weeks, La.
Weiss, Bernard, New York, N. Y.
Wheatley, Norman, Harefield, Middlesex, England
Wickland, Joseph R., Philadelphia, Pa.
Williams, Irving, Brooklyn, N. Y.
Wilson, Guy W., Erie, Pa.
Youngquist, C. Harry, Chicago, Ill.

CHANGE IN GRADING

Transfers to Fellow

Hockema, Frank C., Lafayette, Ind.
Krieg, Edwin H., Ridgewood, N. J.

Transfers to Member

Ashcroft, Herbert, Jr., Springfield, N. J.
Corbin, Edwin M., New York, N. Y.
Cornell, Donald H., Brecksville, Ohio
Daniels, Arthur N., Peterboro, N. H.
DeLear, Nicholas L., New York, N. Y.
Dieckman, Clifford R., Pottsville, Pa.
Dobson, John G., Denville, N. J.
Feliu, Carlos J., San Juan, Puerto Rico
French, John C., Newport News, Va.
Frewin, Leroy, El Paso, Texas
Gadd, Charles W., Detroit, Mich.
Garey, Robert Bryant, San Jose, Calif.
Haver, Ralph L., San Diego, Calif.
Hein, Jerome J., Riverside, Ill.
Hirth, E. F., Los Angeles, Calif.
Jackson, Thomas E., Bethlehem, Pa.
Lovercheck, Charles Lester, Arlington, Va.
Lucken, Ernest George, Brooklyn, N. Y.
Nixon, Nicholas N., Beaver Falls, Pa.
Pintar, Joe, Los Angeles, Calif.
Seyfarth, Francis, Urbana, Ill.
Tompkins, Sherman A., Long Island City, N. Y.
Whitney, Morgan M., New York, N. Y.

Transfers from Student Member to Junior 115

Necrology

THE deaths of the following members have recently been reported to headquarters:

Abercrombie, James H., November 27, 1947
Card, Frederic M., March 21, 1948
Degen, Daniel J., January 7, 1948
Fletcher, James, October 6, 1947
Herron, James H., March 29, 1948
Knight, George L., March 27, 1948
Placé, Louis V., Jr., September 8, 1947
Rockwell, Robert L., February 10, 1948
Weiss, Herbert A., March 15, 1948
Windenburg, Dwight F., November 14, 1947

ASME Transactions for April, 1948

THE April, 1948, issue of Transactions of the ASME contains the following:

TECHNICAL PAPERS

- The Influence of Reaction Interface Extension in the Combustion of Gaseous Fuel Constituents, by W. J. Wohlenberg (Paper No. 47—A-27)
- High-Output Combustion of Ethyl Alcohol and Air, by A. H. Shapiro, D. Rush, W. A. Reed, D. G. Jordan, and G. Farnell (Paper No. 47—A-25)
- Economies in Power-Plant Design, by E. H. Krieg
- An Investigation of Boiler-Drum Steel After Forty Years of Service, by H. S. Blumberg and G. V. Smith
- Quick Starting of High-Pressure Steam-Turbine Units, by J. C. Falkner, R. S. Williams, and R. H. Hare
- Continuous Determination of Oxygen Concentration Based on the Magnetic Properties of Gases, by R. D. Richardson (Paper No. 47—A-38)
- The 103,000-Hp Turbines at Shasta Dam, by J. F. Roberts (Paper No. 47—A-4)
- Rubber Springs—Shear Loading—II, by J. F. D. Smith (Paper No. 46—SA-20)
- Effect of Some Processing Variables on the Stress Required to Draw Tubular Parts, by George Espey and George Sachs (Paper No. 47—A-10)
- Strength and Failure Characteristics of Thin Circular Membranes, by W. F. Brown, Jr., and George Sachs (Paper No. 47—A-20)
- The Statistics of Boiler Embrittlement, by C. D. Weir
- Oil Flow and Temperature Relations in Lightly Loaded Journal Bearings, by John Boyd and B. P. Robertson (Paper No. 47—A-60)